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MEASUREMENT OF FLYING QUALITIES OF A DOUGLAS A-26B AIRPLANE

(AAF No. 41-39120)

I - LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS

By H. L. Crane, S. A. Sjöberg, and H. H. Hoover

Langley Memorial Aeronautical Laboratory  
Langley Field, Va.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

for the

Army Air Forces, Air Technical Service Command

MEASUREMENT OF FLYING QUALITIES OF A DOUGLAS A-26B AIRPLANE

(AAF No. 41-39120)

I - LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS

By H. L. Crane, S. A. Sjoberg, and H. H. Hoover

INTRODUCTION

At the request of the Army Air Forces, Air Technical Service Command, flight tests have been made to determine the flying qualities of a Douglas A-26B airplane. The results of the tests to determine the longitudinal stability and control characteristics are presented herein. The results of the tests to determine the lateral and directional stability and control characteristics and the stalling characteristics will be presented in later reports. The airplane was received March 13, 1944, and the flight program of flying qualities tests and an additional series of tests to determine the maximum normal-force coefficients of the airplane were completed on May 11, 1944. The whole program required 21 flights and a total flying time of 33 hours.

DESCRIPTION OF AIRPLANE

The A-26B is a three-place, twin-engine, midwing, attack-bombing airplane, having double slotted flaps and a retractable tricycle-type landing gear. With the exception of the control surfaces, which are fabric covered, the airplane is of all-metal construction. All control surfaces are sealed. The airplane is powered by two Pratt and Whitney R-2800-2SB-G engines. There were no spinners on the airplane during the flying qualities tests. The airplane weight varied from 27,000 to 31,000 pounds in the tests. Figures 1 through 4 are photographs of the airplane. A three-view drawing of the airplane, cross sections of the wing and aileron, of the

horizontal and vertical tails, and of the flap in various positions are presented in figures 5 and 6.

The variations of elevator and rudder position with control wheel and rudder pedal position under no load are shown in figures 7 and 8. Elevator and rudder deflection were measured with respect to the thrust axis. Both the stabilizer and vertical fin were set parallel to the thrust axis. General specifications of the airplane are listed in the appendix.

### INSTRUMENTATION

The following instruments and cameras were mounted in the airplane:

Measured Quantity	NACA Instrument
1. Time	Timer (synchronizing all records)
2. Airspeed	Airspeed recorder
3. Control positions	Control-position recorders
4. Control forces	Strain-gage pedal-force and wheel-force recorders
5. Sideslip angle	Yaw-angle recorder
6. Angle of bank	Recording inclinometer
7. Normal, longitudinal and transverse accelerations	Three-component recording accelerometer and indicating normal accelerometer
8. Angular velocities	Rolling-velocity, pitching-velocity and yawing-velocity recorders
9. Free-air temperature	Electrical resistance-bulb type thermometer
10. Internal pressure of elevator and ailerons	Two cell pressure recorder

Measured Quantity	NACA Instrument
11. Flap position	Position recorder on out-board end of flap
12. Aileron fabric deflection (top)	35-millimeter motion-picture camera with telescopic lens
13. Elevator fabric deflection (top and bottom)	Two 16-millimeter gun cameras

Correct service indicated airspeed as used herein is defined by the formula  $V_i = 45.08 f_0 \sqrt{q_c}$  where  $V_i$  is in miles per hour,  $q_c$  is the difference between total pressure and static pressure in inches of water, and  $f_0$  is the compressibility correction factor at sea level. Static pressure was measured with a swiveling static head mounted 1 chord length ahead of and slightly below the right wing tip. The static head was calibrated by means of a trailing airspeed bomb. Total pressure was measured with a shielded total head.

A two-component mechanical control-position recorder was connected to the elevator and rudder horns. No attempt has been made to correct the elevator and rudder angles for twist of the surfaces. To obtain an approximate measure of the stretch in the control system a three-component control-position recorder was attached to the elevator, rudder, and aileron control cables in the cockpit. The stretch of the elevator control system between the cockpit control horn and the elevator horn was  $1^\circ$  per 18 pounds of wheel force. The stretch of the rudder system between the pedals and the rudder horn was  $1^\circ$  per 60 pounds pedal force.

Aileron positions were measured by an electrical control-position recorder, the transmitting elements of which were connected to the center of each aileron.

## TESTS, RESULTS, AND DISCUSSION

The results of the tests are evaluated in terms of the specifications of reference 1.



## A. Longitudinal Stability and Control Characteristics.

### 1-A. Dynamic longitudinal stability

The control-free short-period longitudinal oscillation was investigated by abruptly deflecting and releasing the elevator at indicated airspeeds of 285, 310, and 348 miles per hour with the center-of-gravity at 28 percent mean aerodynamic chord. No oscillation of the elevator or the airplane resulted at any of the test speeds. Typical time histories of a pull-up and a push-down at 285 miles per hour are shown in figure 9.

### 2-A. Static longitudinal stability

The static longitudinal stability measurements were made at three center-of-gravity positions, approximately 23, 28, and 32 percent of the mean aerodynamic chord, with the flaps and landing gear up. Check flights were made in some conditions at center-of-gravity positions differing slightly from the two forward center-of-gravity positions. Lowering the landing gear shifts the center-of-gravity forward approximately 2 percent of the mean aerodynamic chord. The weight of the airplane varied from approximately 27,000 to 31,000 pounds in the tests. Account has been taken of the change in weight and center-of-gravity position during flight due to fuel consumption. The conditions in which the airplane was tested and the figures showing the data obtained for the three center-of-gravity positions are shown in the following table:

Condition	Power setting 6000 to 10,000 ft	Position of				Approximate trim speed	Figure
		Flaps	Landing gear	Cowl flaps	Oil cooler		
Rated power, clean	41.5 in. Hg 2400 rpm	Up	Up	Closed	1/2 open	Speed for level flight	10
Cruising (75 percent power)	34 in. Hg 2100 rpm	Up	Up	Closed	---do---	Speed for level flight	11
Gliding	Engines idling	Up	Up	Closed	---do---	Same tab settings as in rated power, clean condition	12
Approach (50 percent power)	30 in. Hg 2400 rpm	Down	Down	Closed	---do---	$V_i = 140$ mph	13
Landing	Engines idling	Down	Down	Closed	---do---	$V_i = 135$ mph	14
Wave-off	41.5 in. Hg 2400 rpm	Down	Down	Open	---do---	$V_i = 140$ mph	15
Take-off	41.5 in. Hg 2400 rpm	1/3 down	Down	Open	---do---	$V_i = 150$ mph	16

Figures 10 through 16 present the directional trim characteristics in addition to the static longitudinal stability characteristics.

Figure 17 shows the variation of elevator angle,  $\delta_e$  and elevator force divided by dynamic pressure,  $\frac{F_e}{q_c}$ , with airplane normal-force coefficient,  $C_N$ , for the cruising condition. The stick-fixed and stick-free neutral points were determined from the slopes of curves of this type. For a given normal force coefficient the neutral points are at the center-of gravity positions at which the slopes  $\frac{d\delta_e}{dC_N}$  and  $\frac{dF_e/q_c}{dC_N}$  are zero. The determination of neutral points in each flight condition for several normal force coefficients is shown in figures 18 through 24. Figures 25 and 26 show the variation of stick-fixed and stick-free neutral points with normal-force coefficient.

The requirements of reference 1 state that with the center-of-gravity at its rearward limit, the curve of elevator angle against speed must have a stable slope and the curve of elevator force against speed must cross zero only once with push forces being required at speeds above the trim speed and pull forces at speeds below the trim speed. These requirements are for a definite speed range depending upon the airplane configuration. For this airplane the service rearward center-of-gravity limit was given as 32 percent of the mean aerodynamic chord with no reference to landing gear position. The most rearward center-of-gravity position tested was at 32 percent of the mean aerodynamic chord with the landing gear retracted and 30 percent of the mean aerodynamic chord with the landing gear extended. Comparison of the data obtained for the aft center-of-gravity position with the requirements of reference 1 leads to the following conclusions:

1. Cruising condition (fig. 11)

The curves of elevator angle and force against speed satisfied the requirements from the highest speed tested to the speed for the best rate of climb, approximately 175 miles per hour. The data indicate that the airplane would be stable at the maximum permissible diving speed thus satisfying the requirement.

## 2. Approach condition (fig. 13)

The airplane was unstable stick fixed at speeds above approximately 110 miles per hour and unstable stick free at speeds above approximately 125 miles per hour. The speeds at which instability will occur vary slightly with the weight of the airplane. The airplane was tested in this condition at a weight of about 28,500 pounds. The requirement of reference 1 was not satisfied.

## 3. Landing condition (fig. 14)

The requirement was satisfied as the airplane was stable stick fixed and stick free throughout the permissible speed range.

## 4. Diving (measurements were made in both the gliding and rated power clean conditions to correspond to the diving condition of reference 1). (See figs. 10 and 12.)

The airplane was stable both stick fixed and stick free from high level flight speed to the highest speed tested and the data indicated that the airplane would be stable up to the maximum permissible diving speed. The requirement was therefore satisfied.

The climbing and cruising maximum range conditions were not tested as specified in reference 1. However, the cruising condition as tested differs from the climbing condition as specified in reference 1 only in the trim speed. The power of the elevator trimming tab is presented in figure 35 so that the static stability curves for any trim speed may be calculated from the data of figures 10 through 16. The cruising maximum range condition is approximately the same as the cruising condition. Examination of the neutral point data of figures 25 and 26 indicates that the stick-fixed stability requirements of reference 1 are satisfied in the climbing and cruising maximum range conditions. In the cruising maximum range condition the airplane would be stable stick-free with the center-of-gravity at 32 percent of the mean aerodynamic chord at airspeeds above 175 miles per hour, which satisfies the requirement of reference 1, but in the climbing condition the

airplane would be neutrally stable at 175 miles per hour, approximately the speed for maximum rate of climb.

Additional conditions tested were the wave-off condition, figure 15, and the take-off condition, figure 16. In the wave-off condition the airplane was unstable stick free with the center of gravity at 30 percent of the mean aerodynamic chord at airspeeds above 120 miles per hour and unstable stick fixed over most of the speed range. In the take-off condition the airplane was stable, stick fixed and stick free, throughout the speed range for the most rearward test center-of-gravity position.

Figure 27 shows the elevator fabric distortion at various speeds. The fabric distortion was not measurably affected by changes in elevator deflection in flight. There is a possibility that the fabric distortion was responsible for the large rearward shift of the stick-free neutral points with increase in speed that was observed. Calculations indicate that small changes in the contour of the elevator surface such as those shown in figure 27 can have relatively large effects on the stick-force characteristics and on the stick-free neutral-points. A quantitative estimate of the effects of the measured distortion on the hinge-moment coefficients for the elevator does not appear possible, however, because of lack of sufficient knowledge of the relations between surface contour and hinge moments. The internal pressure in the elevator during straight flight is shown as a function of speed in figure 28. At high speeds the internal pressure was approximately 5 percent of the dynamic pressure above true static pressure. At 260 miles per hour the internal pressure was reduced from 6 to 3 percent of the dynamic pressure above static pressure by an 8° increase in up-elevator deflection.

The application of power had a large destabilizing effect on both the stick-fixed and stick-free stability with the flaps up or down. With engines idling, lowering the flaps increased the stick-fixed and stick-free stability. Tuft surveys showed that a flow breakdown occurred over the portion of the wing between the nacelle and

fuselage near the stall, thus reducing the downwash at the tail. The increase in up-elevator deflections and pull forces required near the stall in all flight conditions except the wave-off, as shown in figures 10 through 16, is due to the reduced downwash at the tail.

### 3-A. Longitudinal control

#### 1. Longitudinal control in accelerated flight

The longitudinal stability characteristics in accelerated flight were investigated by making turns of constant acceleration at 10,000 feet with the airspeed gradually decreasing from maximum level flight speed to the stall warning. A time history of one such turn is presented in figure 29. The variation of elevator control force with speed at various accelerations for the three center-of-gravity locations tested is shown in figure 30. Figure 31 shows the variation of elevator angle with airplane normal-force coefficient in straight flight and in turns at various accelerations up to 3g.

The curves of elevator angle against normal-force coefficient in figure 31 theoretically all approach the same elevator angle at  $C_N = 0$  and diverge as the normal-force coefficient increases because of the effects of propeller operation and curvature of the flight path. The theoretical change in elevator angle due to curvature of the flight path in a 3g turn at a normal-force coefficient of 1.0 for the A-26B airplane is  $2.1^\circ$ . The remainder of the difference in elevator angles between the straight flight condition and a 3.0g turn (about  $1.6^\circ$ ) is attributed to the effects of propeller operation.

The stick-fixed neutral points for turning flight should be determined from the change in elevator required to vary the normal acceleration as the speed is held constant. The data of figure 31 were cross-plotted to obtain curves corresponding to a constant speed. Curves of this type for a speed of 235 miles per hour are shown in figure 31. The slopes of these curves are

plotted against center-of-gravity position in figure 33. The stick-fixed neutral point is at the center-of-gravity position where the slope  $\frac{d\delta_e}{dC_N}$  is zero, and it is shown to be at 43.3 percent mean aerodynamic chord.

The change in elevator control force with change in normal acceleration shown in figure 32 for several speeds at the three test center-of-gravity locations was determined by cross-plotting the data of figure 30. The stick-free neutral point for accelerated flight is at the center-of-gravity position where  $\frac{dF_e}{dn}$  is zero in figure 33.

The symbol  $n$  represents normal acceleration in gravitational units. The location of the stick-free neutral point between 36 and 37 percent mean aerodynamic chord establishes 36 percent as the dangerous aft center-of-gravity position.

The service range of center-of-gravity positions is from 18 to 32 percent mean aerodynamic chord and the design load factor at a gross weight of 30,000 pounds is 3.65g. Figure 33 indicates that the elevator control-force increment per unit acceleration at 240 miles per hour would be approximately 102 pounds per g at the forward service limit of center-of-gravity position and 24 pounds per g at the rearward limit. The control forces for accelerated flight exceed the value of 36.5 pounds per g required by reference 1 with the center of gravity forward of 30 percent mean aerodynamic chord.

Values of elevator hinge-moment parameters  $Ch_a$ , -0.0027, and  $Ch_b$ , -0.0049, were calculated from turning flight data.

## 2. Longitudinal control in landing

The elevator deflection used in landing is presented as a function of center-of-gravity position in figure 34. In some of the landings, the approach was made at a higher speed requiring a more rapid flare. To make a rapid flare the pilot used more up elevator although the airplane was operating at a

lower normal-force coefficient. With the center of gravity at 21 percent of the mean aerodynamic chord at least  $25^\circ$  of up-elevator deflection was required to stall the airplane in the landing condition at altitude. The effect of the ground in landing is to reduce the downwash and require more up-elevator deflection. Since less rather than more than  $25^\circ$  elevator deflection was used during landings with the center of gravity at 21 percent of the mean aerodynamic chord, it is probable that none of the landings were fully stalled. At only a few miles per hour above the stalling speed the elevator deflections required for trim were greatly reduced. Therefore, although a fully stalled landing could probably not be made with the center of gravity at 18 percent of the mean aerodynamic chord and the requirements of reference 1 were not satisfied, a landing could be made at only a few miles per hour above the stalling speed.

With the center of gravity at 21 percent of the mean aerodynamic chord and the airplane trimmed at 135 miles per hour in the landing condition, the elevator control force required in landing was approximately 45 pounds. Therefore, with the center of gravity at 18 percent of the mean aerodynamic chord, the elevator control force required in landing would probably exceed the 50-pound limit of reference 1.

Because of the difficulties involved in performing power-off landings with the A-26B airplane, the characteristics of the airplane in the landing condition were explored further. The approximate rates of descent in the landing condition were determined using the rate-of-climb indicator. For a wing loading of approximately 51 pounds per square foot the A-26B airplane had an approximate rate of descent of 30 or 35 feet per second with the flaps three-quarters down or full down according to the flap-position indicator and the engines idling at an indicated airspeed of 125 miles per hour. It has been shown in reference 2, in the case of the B-26 airplane, that 25 feet per second was the maximum rate of descent which the pilot considered acceptable.



The pilot considered the landing characteristics of the A-26B airplane with engines idling to be undesirable. The factors primarily responsible for this were the steepness of the glide path and the very nose-down attitude. A third factor was the inadequacy of the elevator for controlling the attitude of the airplane just prior to contact and on the ground immediately after landing, particularly at intermediate and forward center-of-gravity positions.

In landing an airplane, a characteristic or combination of characteristics becomes a shortcoming whenever it prevents the pilot from flaring for a contact at or near zero vertical velocity and at or near minimum airspeed or prevents controlling the attitude of the airplane at contact to keep from banging the nose wheel onto the runway. In the case of the A-26B, the steep glide path and nose-down attitude necessitate a rapid transition from the approach path to a flat path in contact attitude in view of the high vertical velocity. Beginning the flare too soon results in an increased chance of stalling and falling in from some height, while flaring too late increases the possibility of not checking the vertical velocity before striking the ground with undue force. The result, therefore, is that the judgement of the pilot must be more accurate and his action must be fast and well-timed in order to execute a satisfactory landing. The power of the elevator is important in that it limits the ability of the pilot to pitch the airplane as required in flaring and limits his ability to prevent excessive nose-wheel loads imposed by banging the nose down at contact.

The A-26B airplane could be landed easily and safely by employing a small amount of power in the approach to flatten the glide path and decrease the attitude angle. Use of three-quarter flaps instead of full flaps did not give satisfactory landing characteristics in the power-off condition, but improved the landing characteristics.

### 3. Longitudinal control in take-off

With the center-of-gravity at 21 percent mean aerodynamic chord it was possible to raise the nose

wheel at speeds of 60 to 70 miles per hour. Calculations indicate that the requirement that it be possible to assume take-off attitude at 80 percent of stalling speed for the landing condition would probably be satisfied with the center of gravity at 18 percent mean aerodynamic chord.

#### 4. Longitudinal trimming control

The power of the elevator trimming tab is shown in figure 35. At high speed the change in elevator hinge-moment coefficient per degree of trimming-tab deflection was 0.0029. It was possible to trim the elevator control forces to zero for center-of-gravity positions between 21 and 32 percent mean aerodynamic chord above approximately 120 percent of the stalling speed in all conditions tested. The requirements of reference 1 would probably be satisfied with the center-of-gravity at 18 percent mean aerodynamic chord.

#### 5. Trim changes due to flaps and power

The trim changes due to flaps and power at an indicated airspeed of 135 miles per hour with the center-of-gravity at 28 percent mean aerodynamic chord and the elevator trimming tab 1.0° up are presented in the following table:

Position of		Power setting	Approximate elevator control force (lb)
Flaps	Landing gear		
Up	Up	Rated, 41.5 in. Hg 2400 rpm	0
Up	Up	Engines idling	17 pull
Down	Down	Rated 41.5 in. Hg 2400 rpm	18 pull
Down	Up	-----Do-----	10 pull
Down	Down	Engines idling	26 pull

The largest trim change was well below the allowable limit of 50 pounds established by reference 1. Another desirable feature was the fact that lowering the flaps produced a diving moment which is less objectionable to a pilot than a nosing-up moment would be.

Although the requirement of reference 1 was satisfied, the tests indicated that a more critical condition with regard to trim changes would exist if the airplane were initially trimmed in the landing condition. The trim changes occurring from this condition with the airplane initially trimmed at 135 miles per hour with trimming tab setting of  $13.6^\circ$  down may be summarized as follows:

Position of		Power setting	Approximate elevator control force
Flaps	Landing gear		
Down	Down	Engines idling	0
Up	Up	Engines idling	23 push
Up	Up	41.5 in. Hg 2400 rpm	75 push
Down	Down	41.5 in. Hg 2400 rpm	18 push

## 6. Pitching moment due to sideslip

Less than a 10-pound increment of elevator control force was required to counteract the pitching moment due to sideslip produced by a rudder force of 180 pounds in the rated power, clean condition at 320 miles per hour. At lower speeds in the clean condition the increment of elevator control force in sideslips was very small.

## CONTROL FRICTION

Plots of the friction in the elevator and rudder systems are presented in figures 36 and 37. The measurements were made on the ground at a temperature of about 60° F. As shown below the friction met the requirements of reference 2.

Control	Friction at neutral deflection	Maximum allowable friction at neutral deflection
Elevator	±6.5	±8.5
Rudder	±6.5	±20.
Aileron	±4.0	±4.3

## CONCLUSIONS

The conclusions reached regarding the longitudinal stability and control characteristics of the A-26B airplane may be summarized as follows:

1. Abruptly deflecting and releasing the elevator produced no oscillation of the elevator or airplane.
2. With the center of gravity at 32 percent mean aerodynamic chord the airplane had satisfactory stick-fixed stability except in the conditions with flaps full down and power on.
3. The airplane did not satisfy the requirements of reference 1 for stick-free stability with the center of gravity at 30 percent mean aerodynamic chord (32 percent with landing gear up) in the conditions with

flaps full down and power on or in the climbing condition where neutral stability existed at the speed for maximum rate of climb.

4. The increment of elevator control force per unit acceleration was in excess of the limit recommended in reference 1, 36.5 pounds per g for the A-26, with the center of gravity forward of 30 percent of the mean aerodynamic chord. At the forward center-of-gravity limit the control-force gradient would be 102 pounds per g.

The location of the stick-free maneuver point between 36 and 37 percent of the mean aerodynamic chord established 36 percent as the dangerous aft center-of-gravity position.

5. With the center of gravity at 18 percent of the mean aerodynamic chord, a fully stalled landing could not be made and the requirements of reference 1 were not satisfied but the elevator control would be sufficient to make a landing at a few miles per hour above the stalling speed.

6. The power of the elevator trimming tab was sufficient to trim the control forces to zero above approximately 120 percent of the stalling speed in all conditions tested with the center-of-gravity between 21 and 32 percent of the mean aerodynamic chord.

7. The trim changes due to power and flaps were not excessive except when the airplane was trimmed for

power-off flap-down flight and full power was applied and the flaps were retracted.

Langley Memorial Aeronautical Laboratory  
National Advisory Committee for Aeronautics  
Langley Field, Va., December 6, 1944

## APPENDIX

## GENERAL SPECIFICATIONS OF THE AIRPLANE

Name and type . . . . . Douglas A-26B  
(AAF No. 41-39120)

Engines (2) . . . . . Pratt and Whitney R-2800-2SB-G  
Rating  
Take-off . . . . . 2000 hp-52 in. Hg-2700 rpm  
Military . . . . . 1950 hp-50.5 in. Hg-2700 rpm 1500 ft  
1600 hp-47.0 in. Hg-2700 rpm 12000 ft  
Maximum continuous . . . . . 1500 hp-41.5 in. Hg-2400 rpm  
5300 ft

Supercharger . . . . . Two-speed, single-stage  
Gear ratio 7.6:1, 9.9:1

Propeller . . . . . Hamilton Standard  
Diameter . . . . . 12 ft 6 in.  
Number of blades . . . . . 3  
Gear ratio . . . . . 2:1

Fuel capacity, gal.  
Nacelle tanks (2), each . . . . . 300  
Bomb-bay tank . . . . . 125  
Wing auxilliary tanks (2), each . . . . . 100

Oil capacity, gal.  
Nacelle tanks (2), each . . . . . 34

Permissible c.g. range, percent M.A.C. . . . . 18 to 32  
Length over-all (less cannon), ft . . . . . 49 ft 11 in.  
Height . . . . . 18 ft 6 in.

Wing:  
Span, ft . . . . . 70.0  
Area, sq ft . . . . . 540.0  
Airfoil section, root 65,2-215 . . . . . a = 0.8, b = 1.0  
Airfoil section, tip 65,2-215 . . . . . a = 0.5, b = 1.0  
Mean aerodynamic chord, in. . . . . 97.53  
Leading M.A.C. in. aft of L.E. root chord . . . . . 6.1  
Aspect ratio . . . . . 9.07  
Taper ratio . . . . . 0.45  
Dihedral (top face of front beam), deg. . . . . 4.5  
Incidence, root, deg. . . . . 2  
Incidence, tip, deg. . . . . 1  
Sweepback of leading edge . . . . . 1° 54'

Weight for tests, lb . . . . . 27,000 to 31,000

Wing flaps (double slotted):

Area, sq ft . . . . . 65.9  
 Length from fuselage center line, ft . . . . . 22.8  
 Travel (no air load), deg. . . . . 52

Ailerons

Area (aft of hinge line, total of  
 two ailerons including tabs), sq ft . . . . . 27.2  
 Length, ft . . . . . 11.0  
 Balance tab area total, sq ft . . . . . 2.3  
 Trimming tab area (left aileron), sq ft . . . . . 1.15  
 Trimming tab deflection range  
 (deg. from aileron) . . . . . 7.2

Horizontal tail

Span, ft . . . . . 22.69  
 Area, including fuselage, sq ft . . . . . 116.1  
 Incidence, deg. . . . . 0  
 Dihedral . . . . . 10° 36'  
 Elevator area, sq ft (aft of hinge line) . . . . . 32.7  
 Trimming tab area, total sq ft . . . . . 2.6  
 Trimming tab deflection range  
 (deg. from elevator) . . . . . 12.2 up,  
 17.1 down  
 Percent balance of elevator . . . . . 31.5  
 Distance elevator hinge line to  
 25 percent M.A.C. of wing, ft . . . . . 30.05

Vertical tail

Area excluding dorsal, sq ft . . . . . 71.35  
 Height above top of fuselage, ft . . . . . 10.0  
 Offset from thrust axis, deg . . . . . 0  
 Rudder area, (aft of hinge line) sq ft . . . . . 23.1  
 Trimming tab area, sq ft . . . . . 2.28  
 Trimming tab deflection range  
 (deg. from rudder) . . . . . 20.5 right,  
 19.5 left



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2. Gustafson, F. B., and O'Sullivan, William J., Jr.: The Effect of High Wing Loading on Landing Technique and Distance, with Experimental Data for the B-26 Airplane. NACA ARR No. L4K07, 1945.

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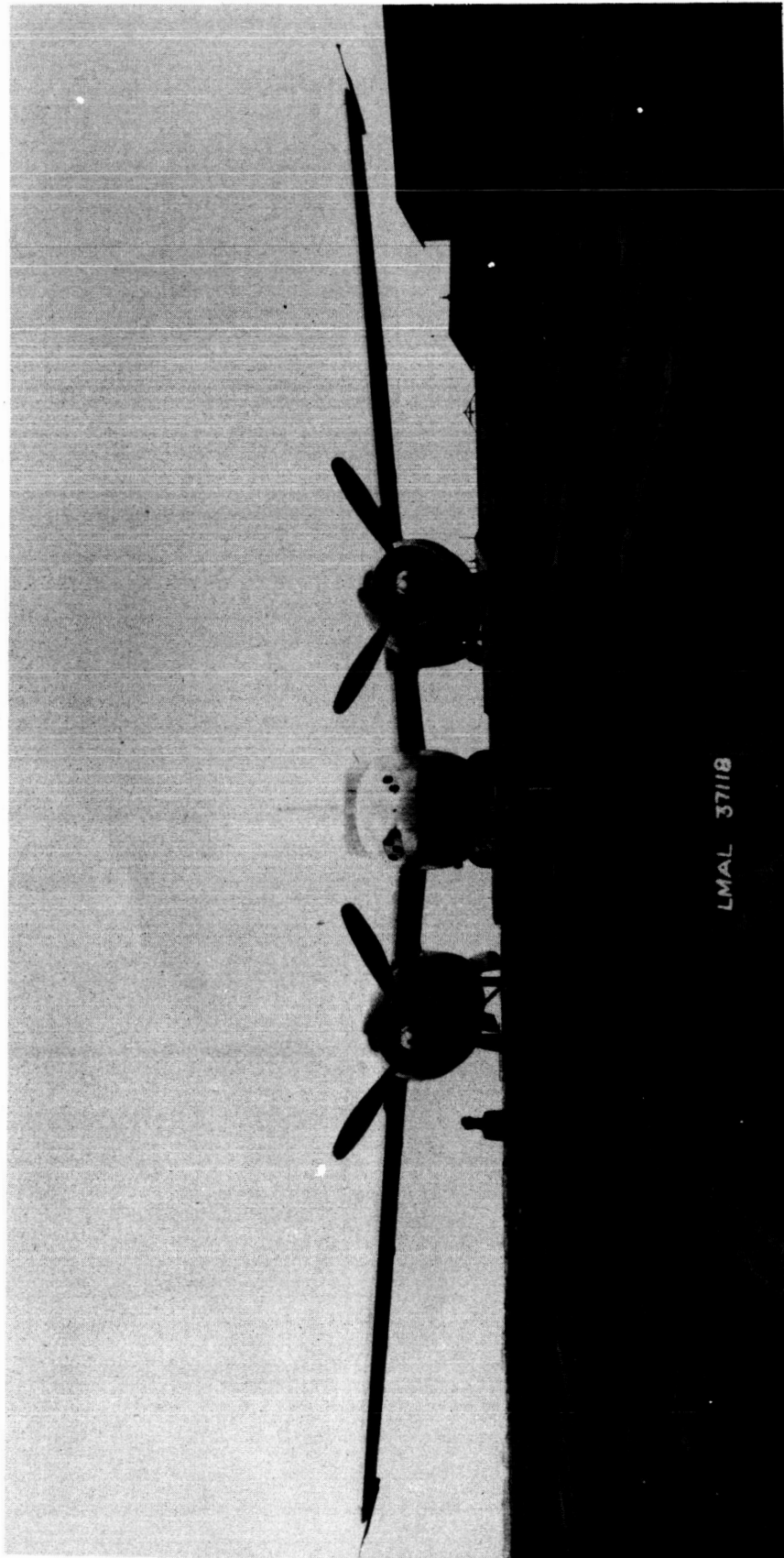


Figure 1.- Front view of Douglas A-26B airplane.

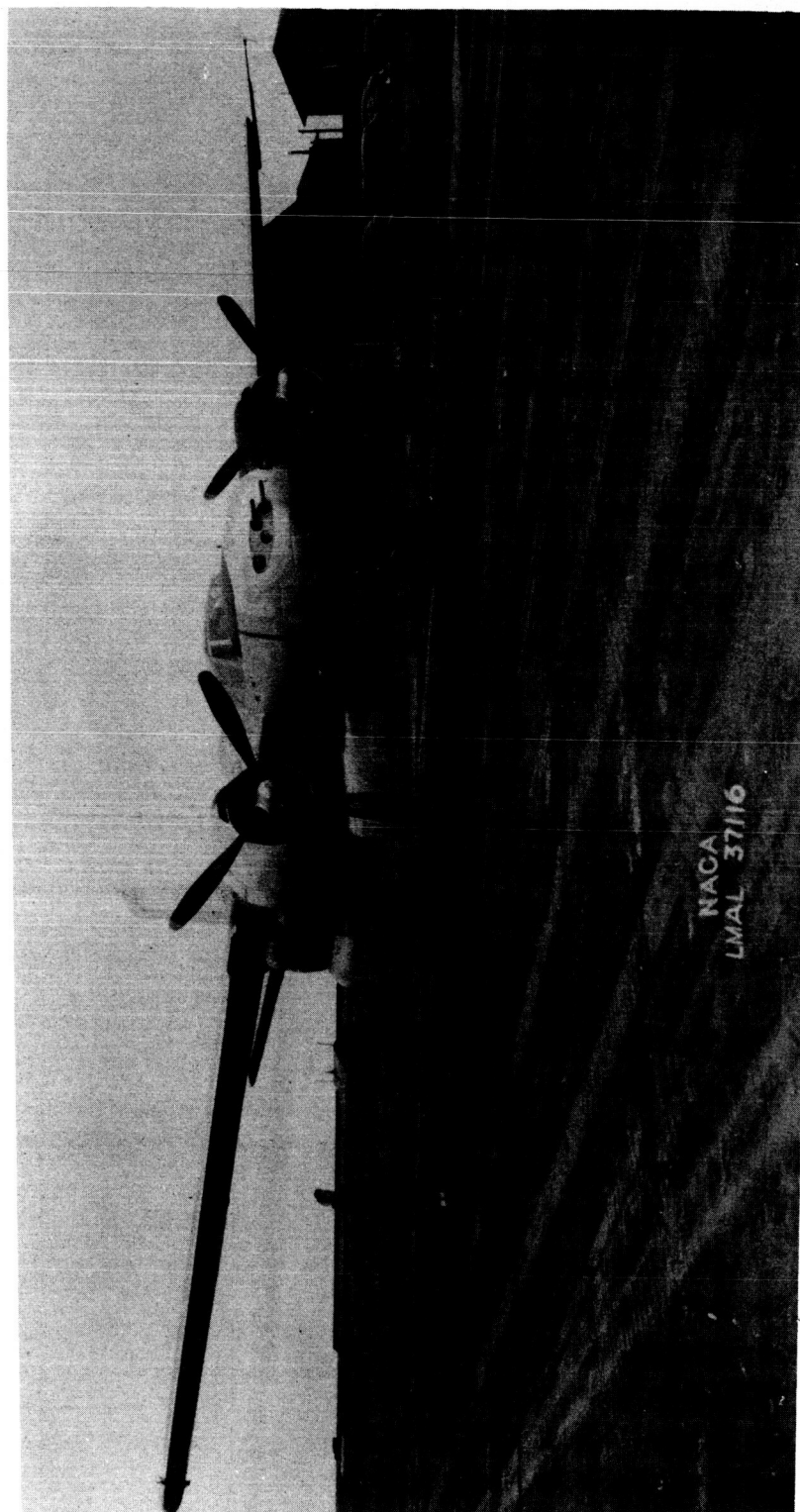


Figure 2.- Three-quarter front view of Douglas A-26B airplane.

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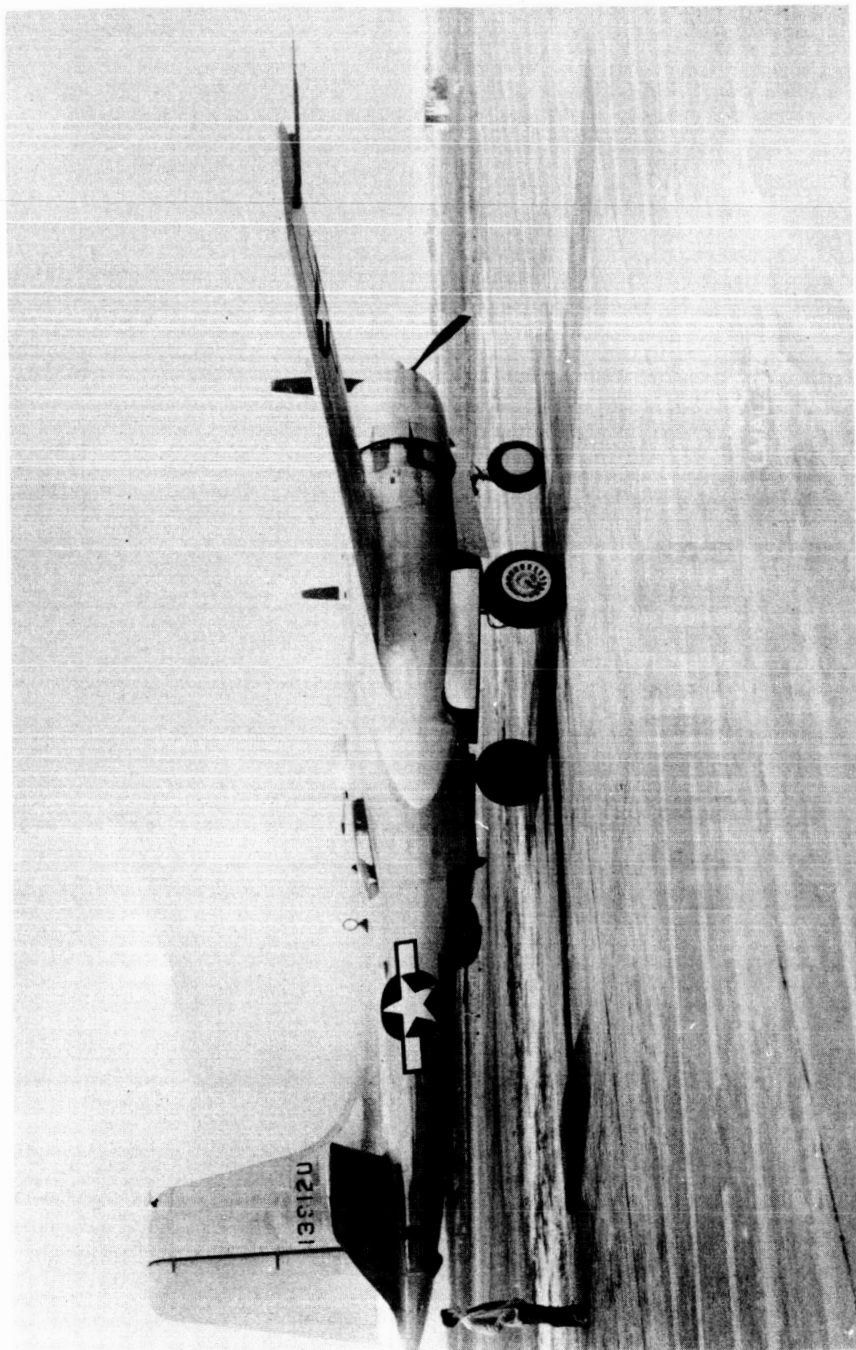


Figure 3.- Three-quarter rear view of Douglas A-26B airplane.

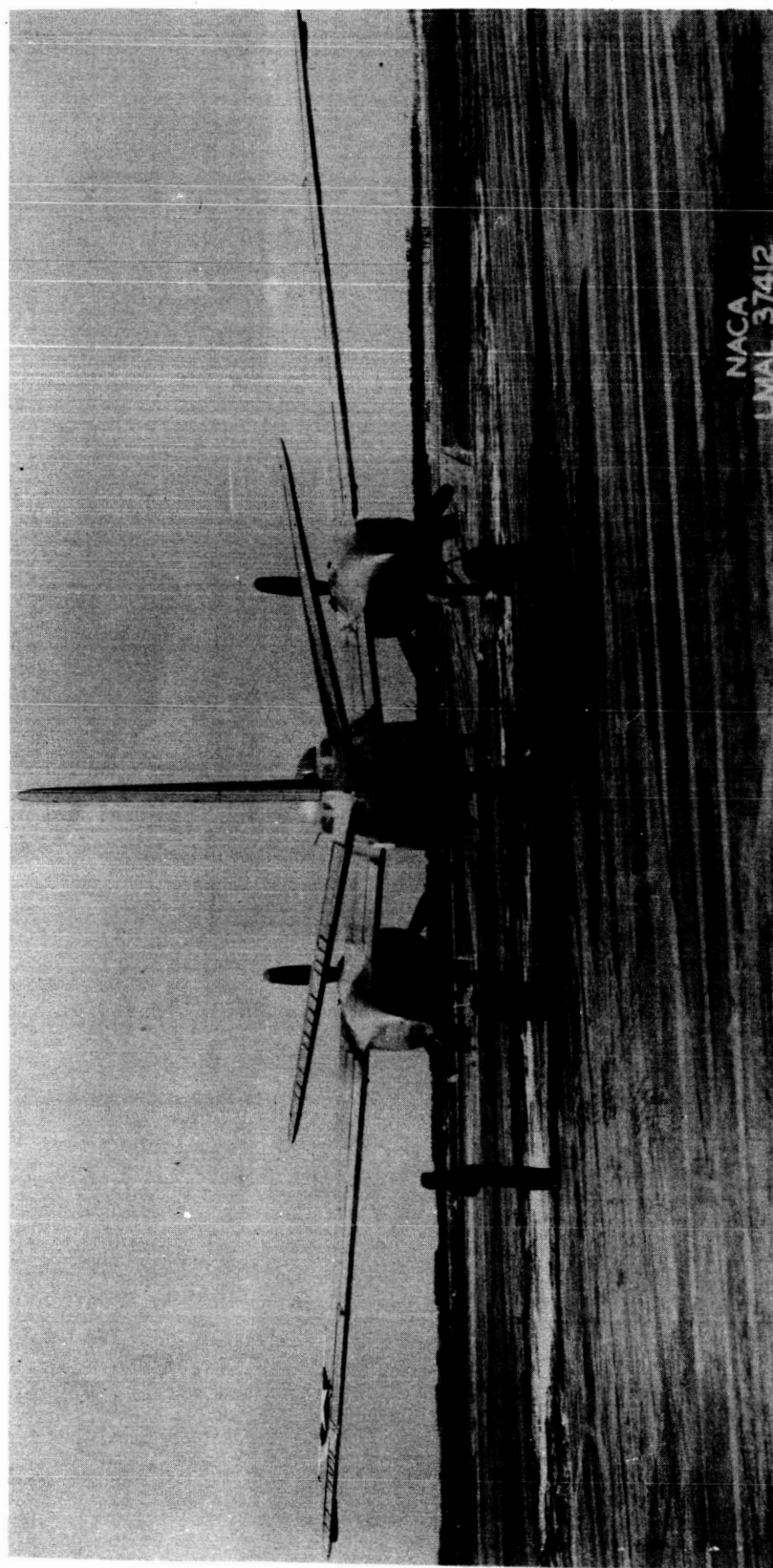


Figure 4.- Rear view of Douglas A-26B airplane.

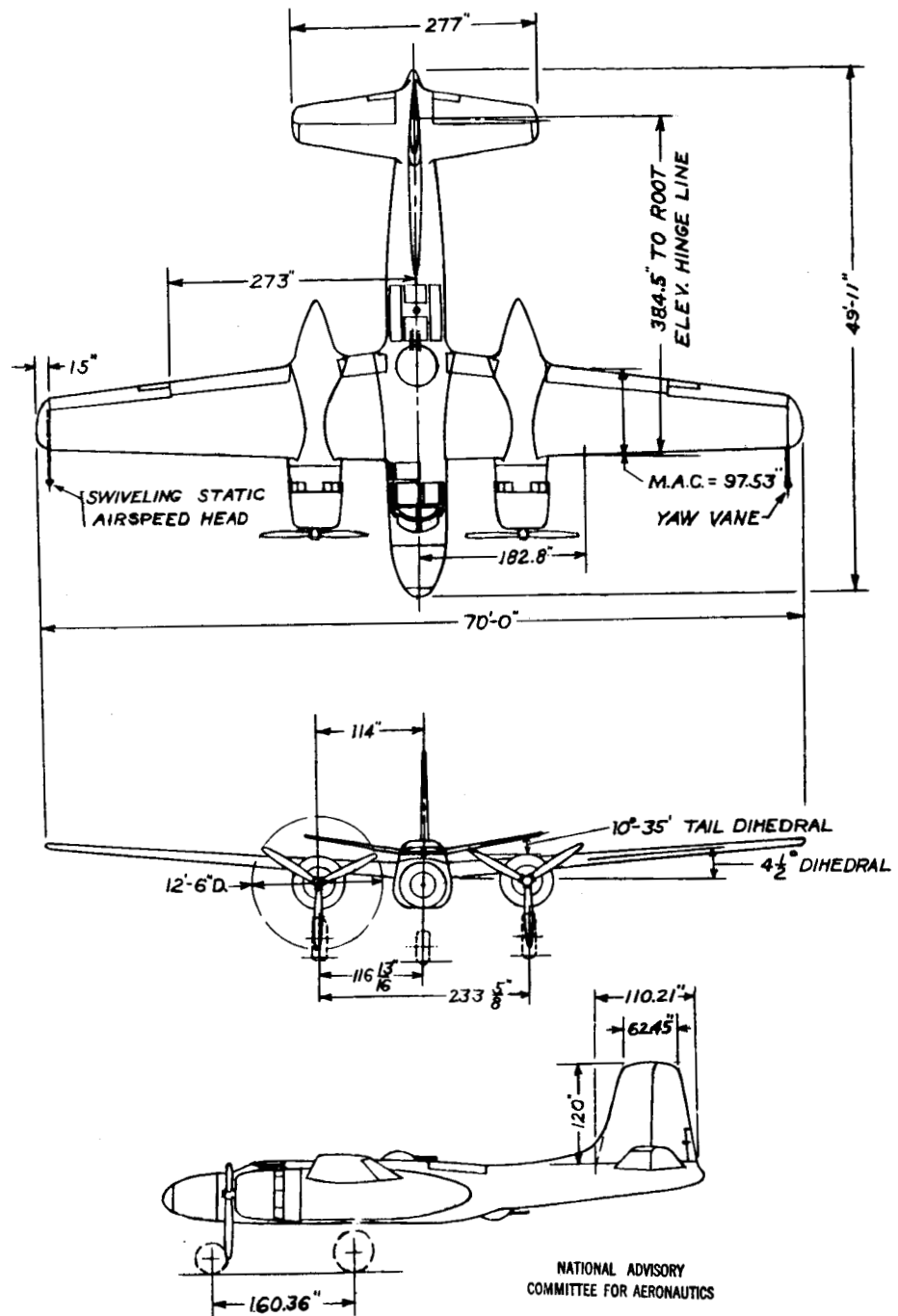
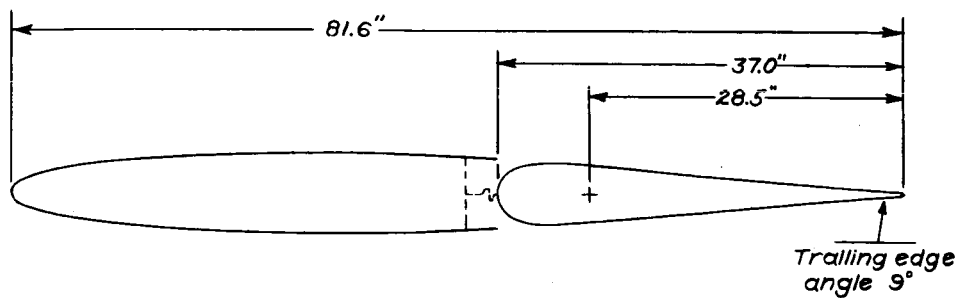
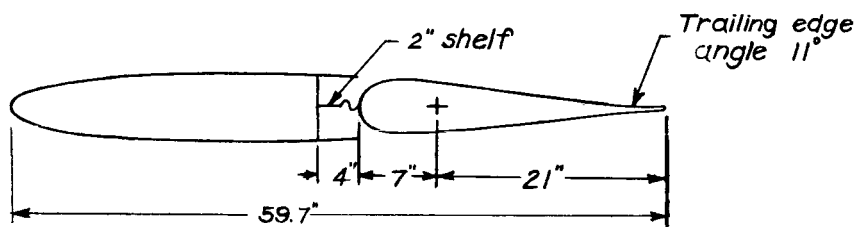


Figure 5.- Three-view drawing of a Douglas A-26B airplane.

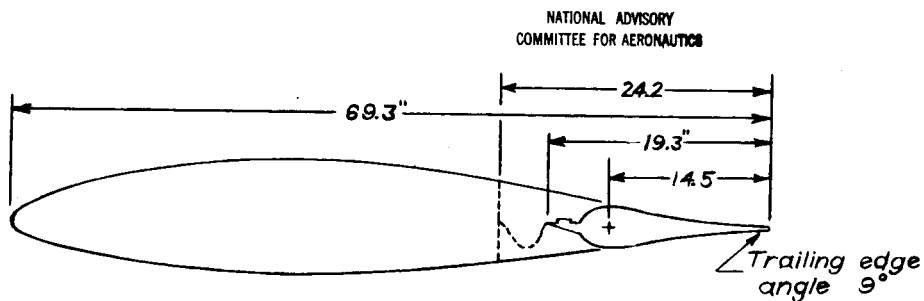
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Section vertical tail 49 inches from tip

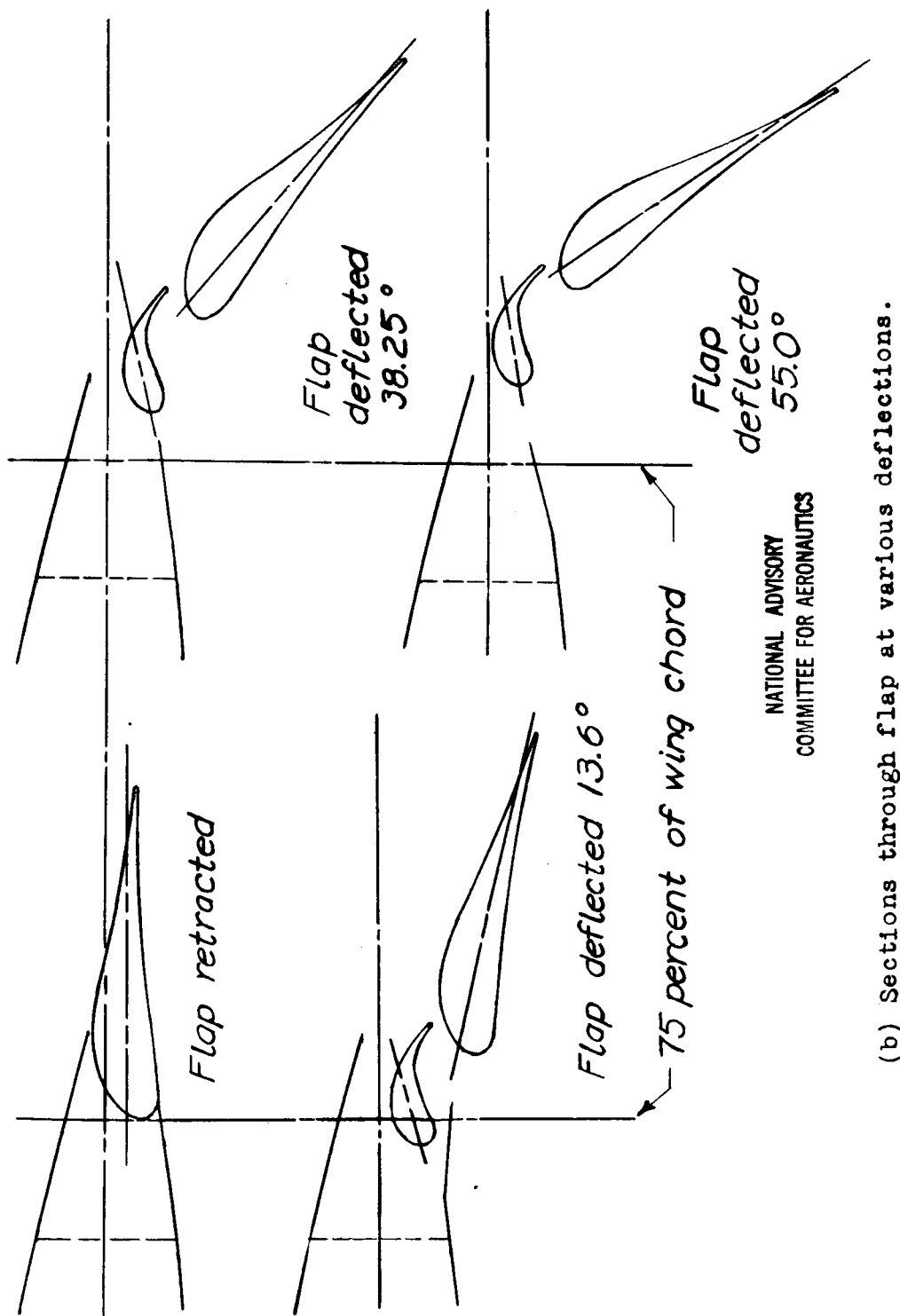


Section of horizontal tail 76.5 inches from airplane center line



Wing section 352 inches from airplane center line

Figure 6(a).- Section views through fin and rudder, stabilizer and elevator, and wing and aileron. Douglas A-26B airplane.



(b) Sections through flap at various deflections.

Figure 6.- Concluded.



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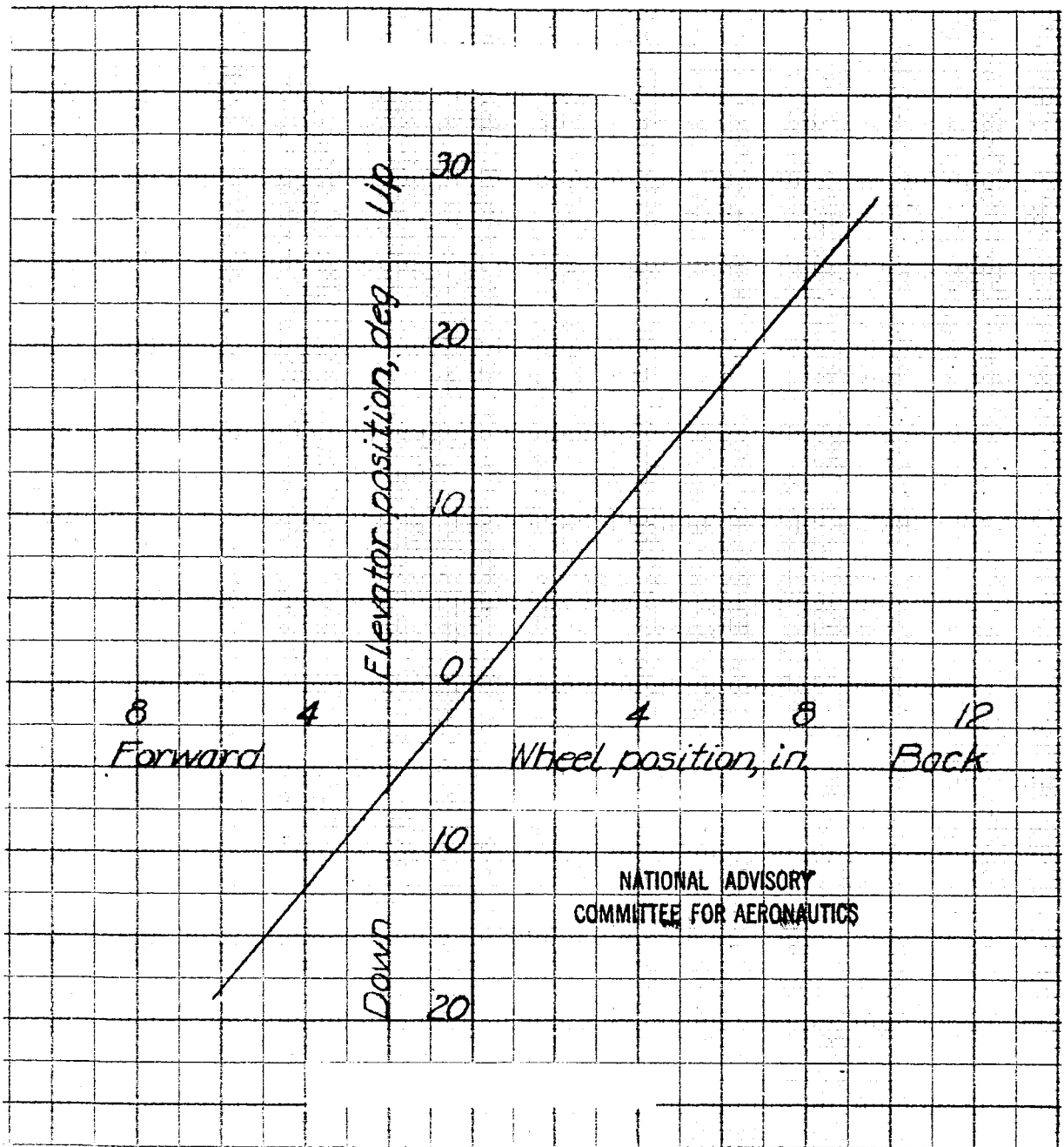
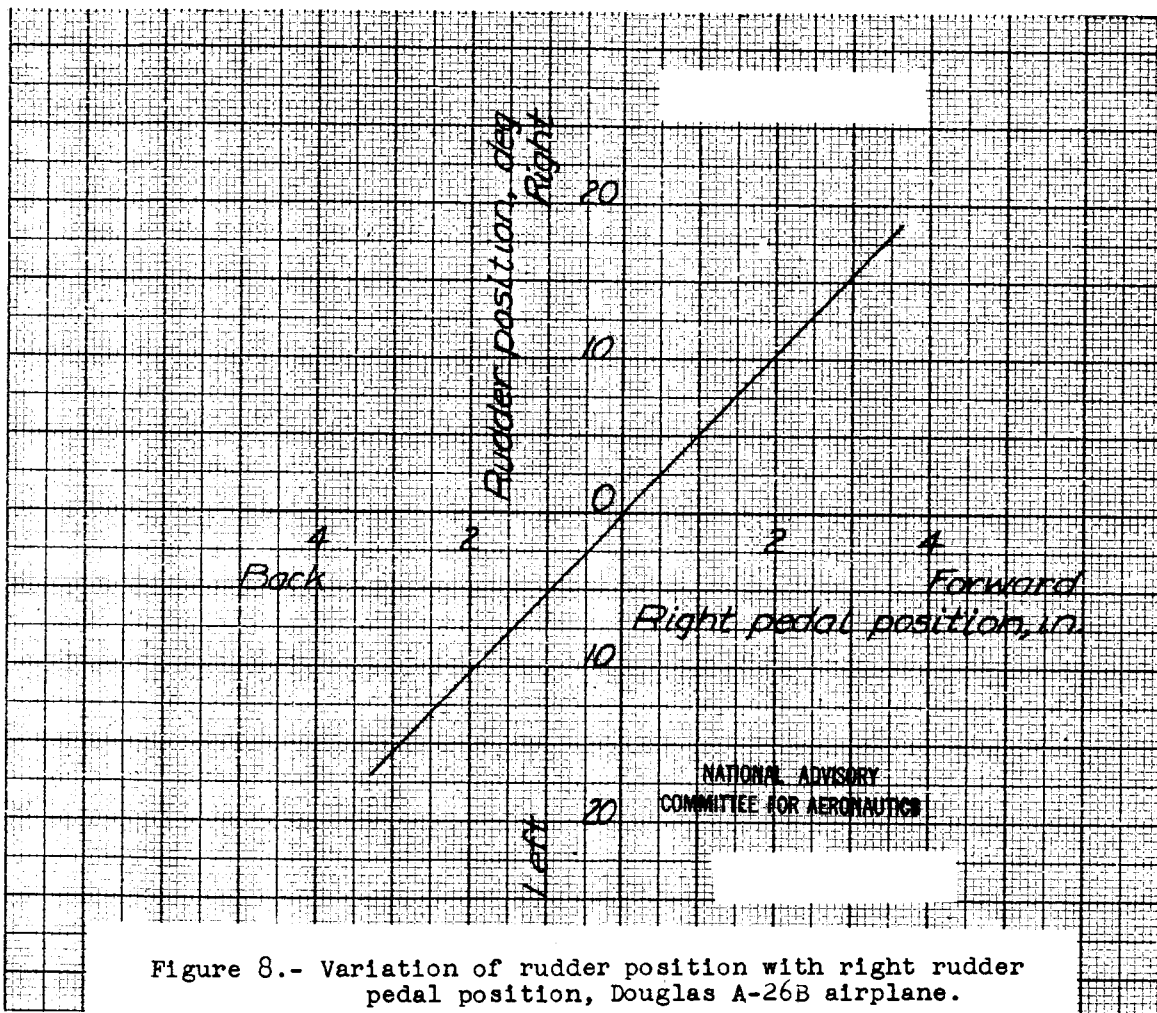


Figure 7.- Variation of elevator position with control wheel position, Douglas A-26B airplane.



L-605

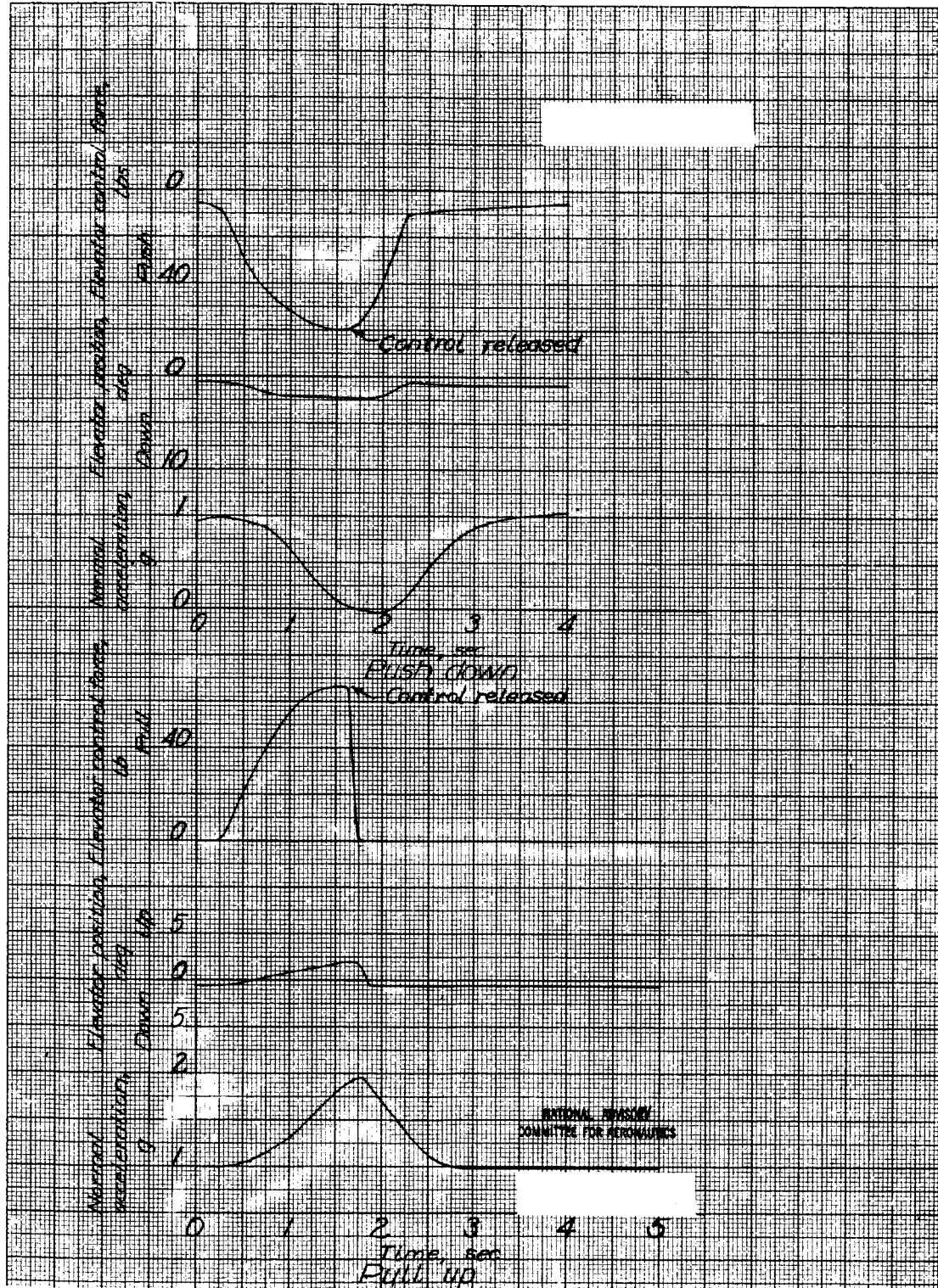


Figure 9.- Time history of a pull-up and push-down from level flight at 285 miles per hour in the rated-power, clean condition (41.5 in. Hg at 2400 rpm, flaps up, landing gear up), c.g. at 28 percent M.A.C., Douglas A-26B airplane.

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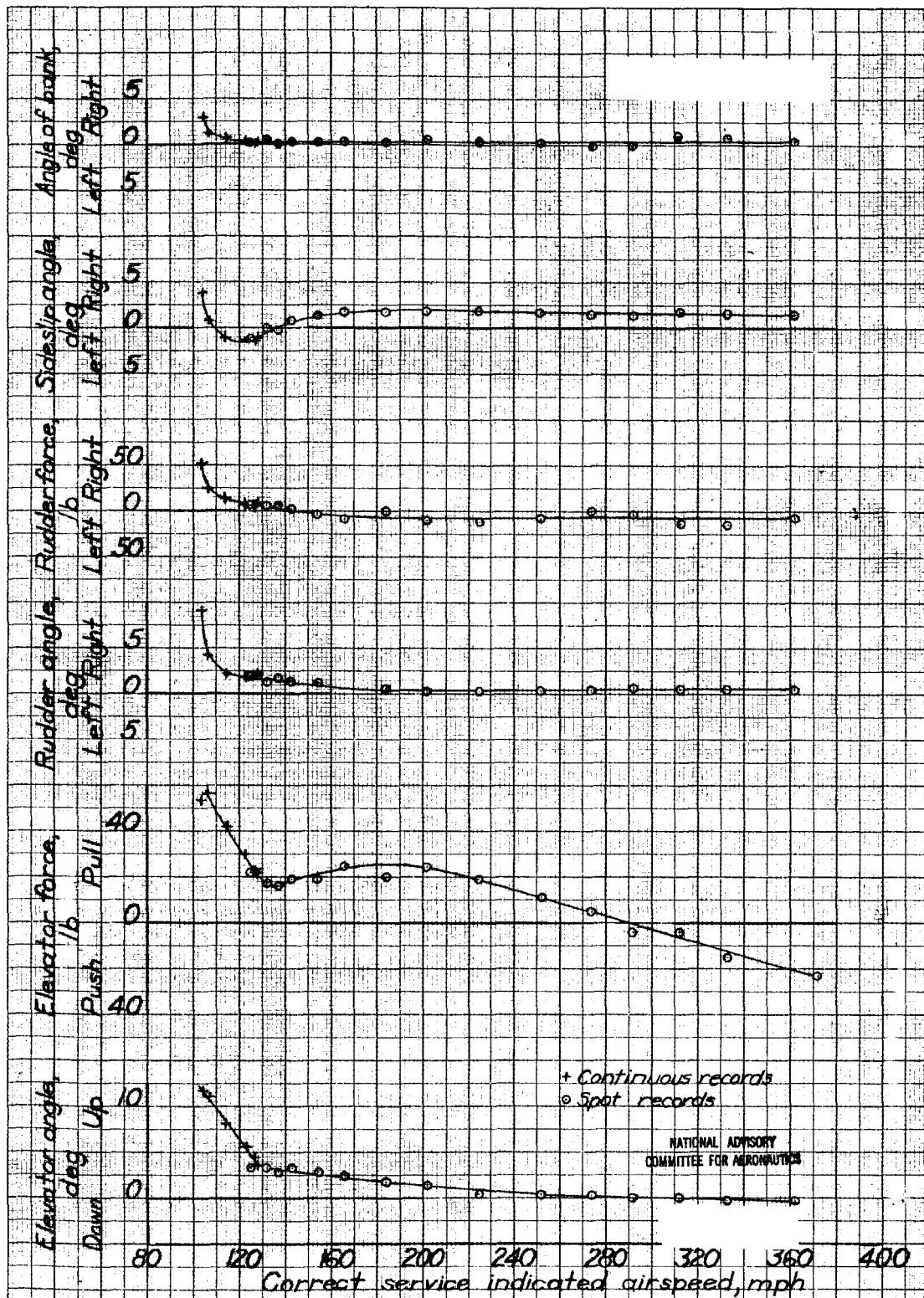
(a) c.g. at 23.2 percent M.A.C., elevator tab  $1.2^\circ$  up, rudder tab 0.

Figure 10.- Static longitudinal stability characteristics in the rated power, clean condition (41.5 in. Hg, 2400 rpm at 6000 to 10,000 ft, flaps up, landing gear up), Douglas A-26B airplane.

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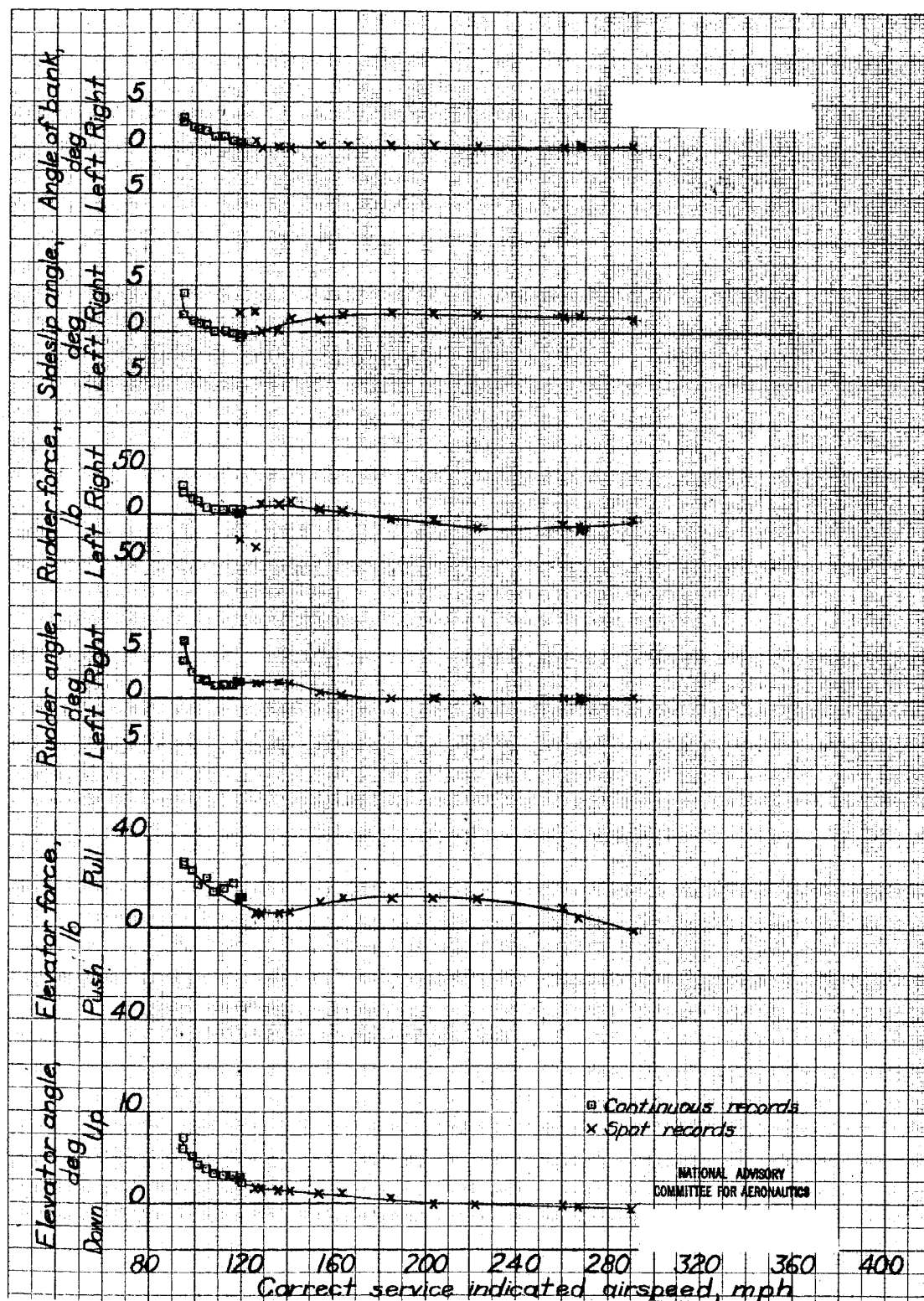
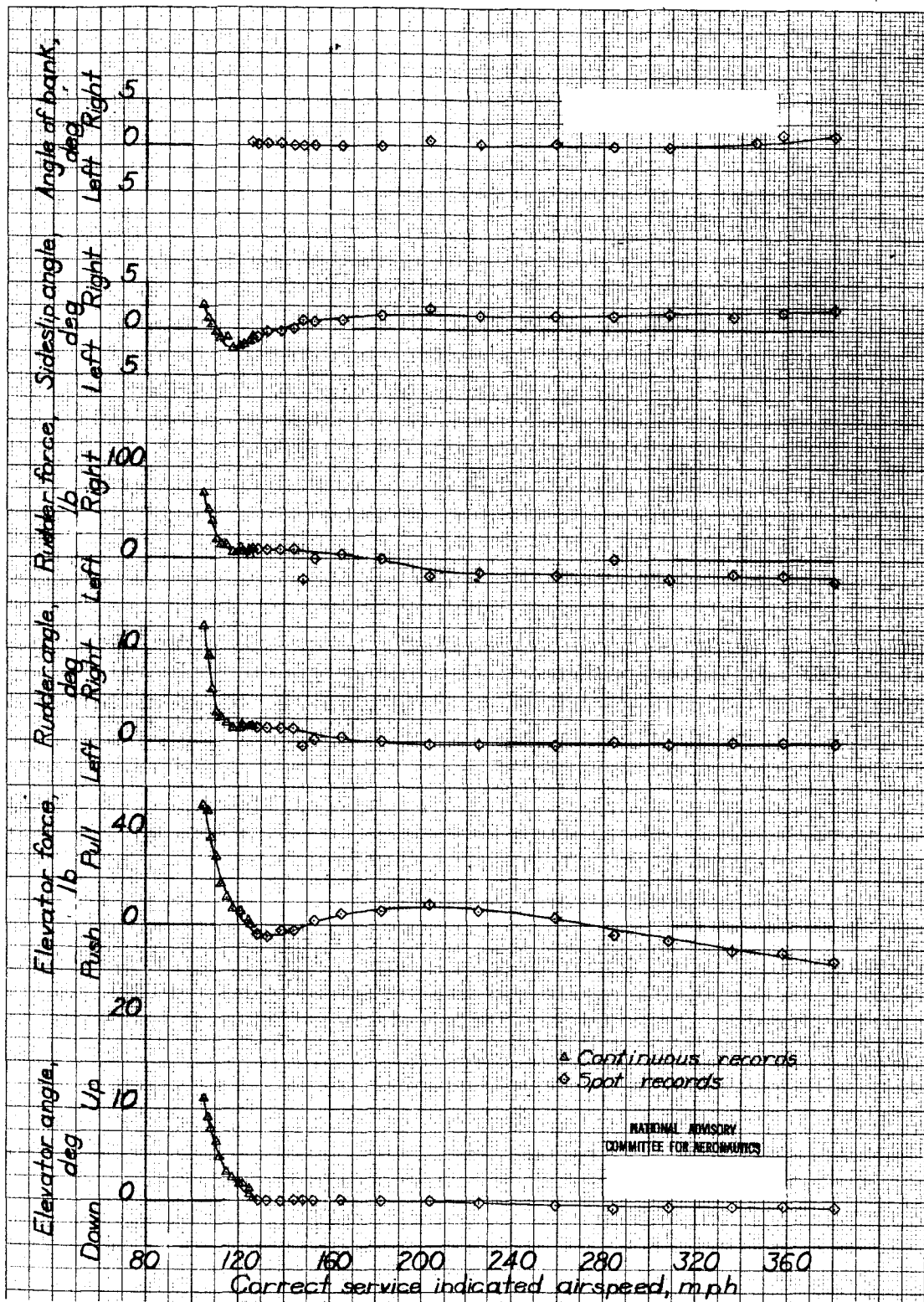
(b) c.g. at 27.6 percent M.A.C., elevator tab  $1.7^\circ$  up, rudder tab  $0.4^\circ$  right.

Figure 10.- Continued.

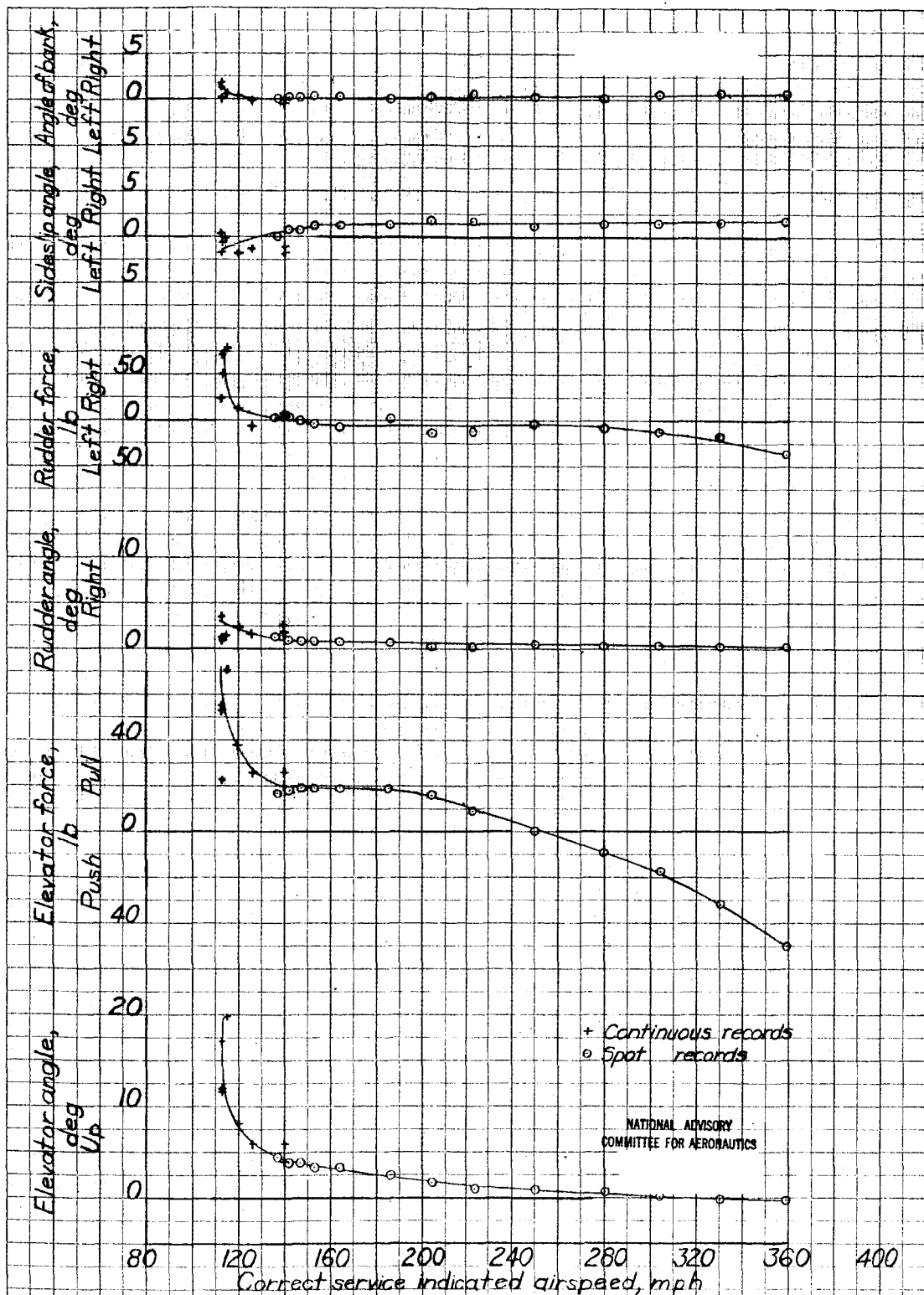


(c) c.g. at 32 percent M.A.C., elevator tab  $2.3^\circ$  up, rudder tab  $0^\circ$ .

Figure 10.- Concluded.



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(a) c.g. at 22.9 percent M.A.C., elevator tab  $0.3^\circ$  down, rudder tab  $0^\circ$ .

Figure 11.- Static longitudinal stability characteristics in the cruising condition (34 in. Hg, 2100 rpm at 6000 to 10,000 ft., flaps up, landing gear up), Douglas A-26B airplane.

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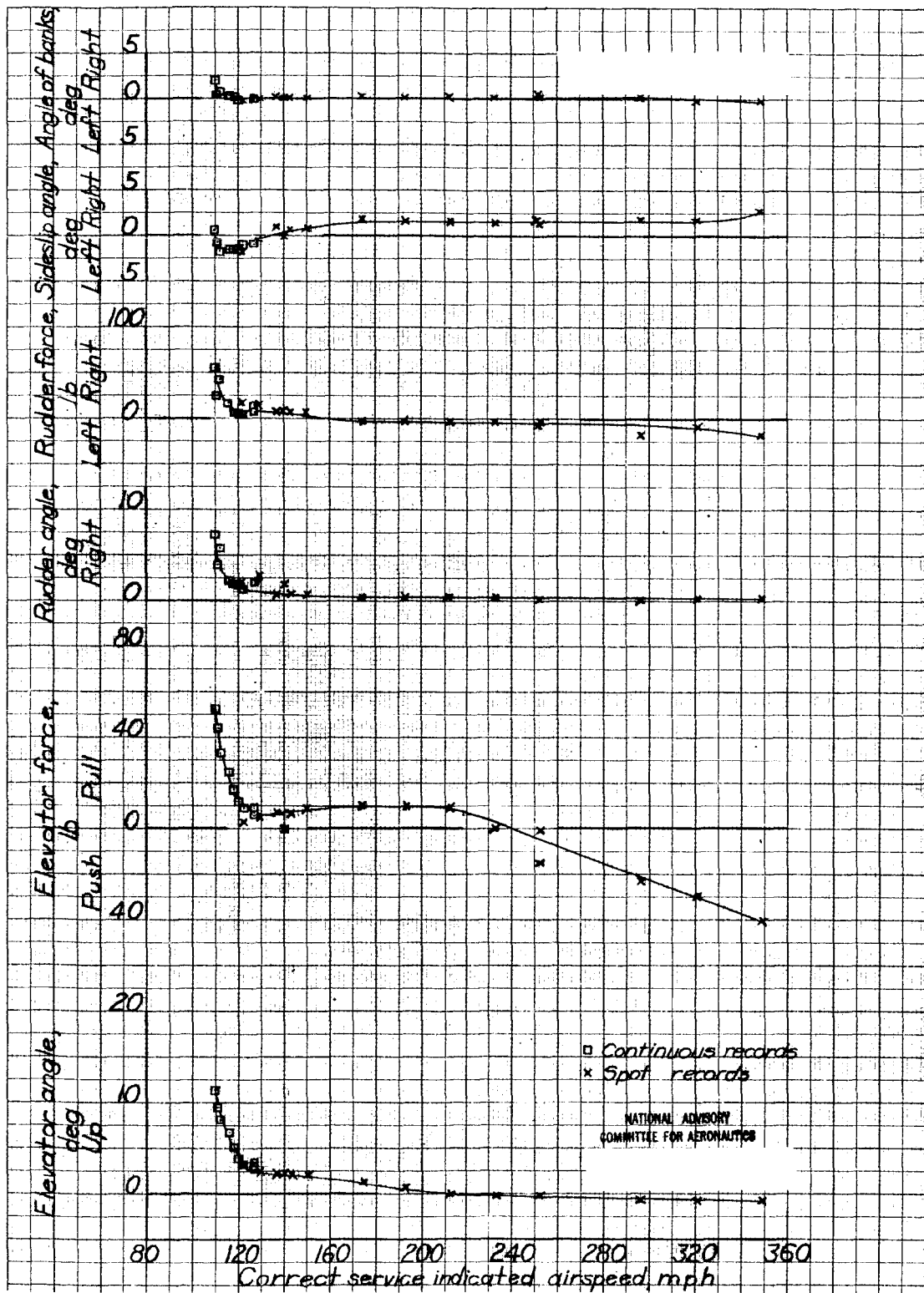
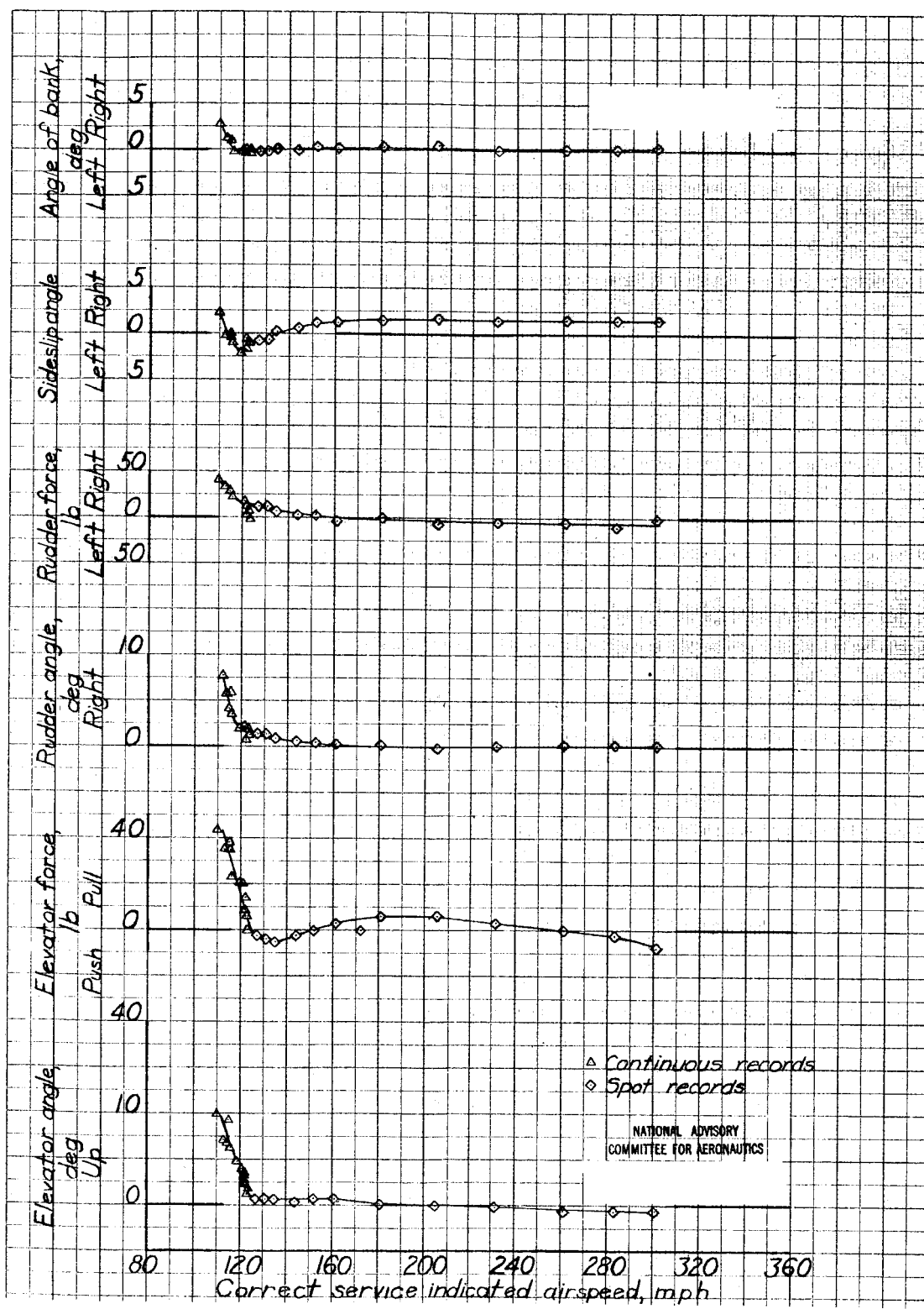
(b) c.g. at 27.8 percent M.A.C., elevator tab  $1.2^\circ$  up, rudder tab  $0^\circ$ .

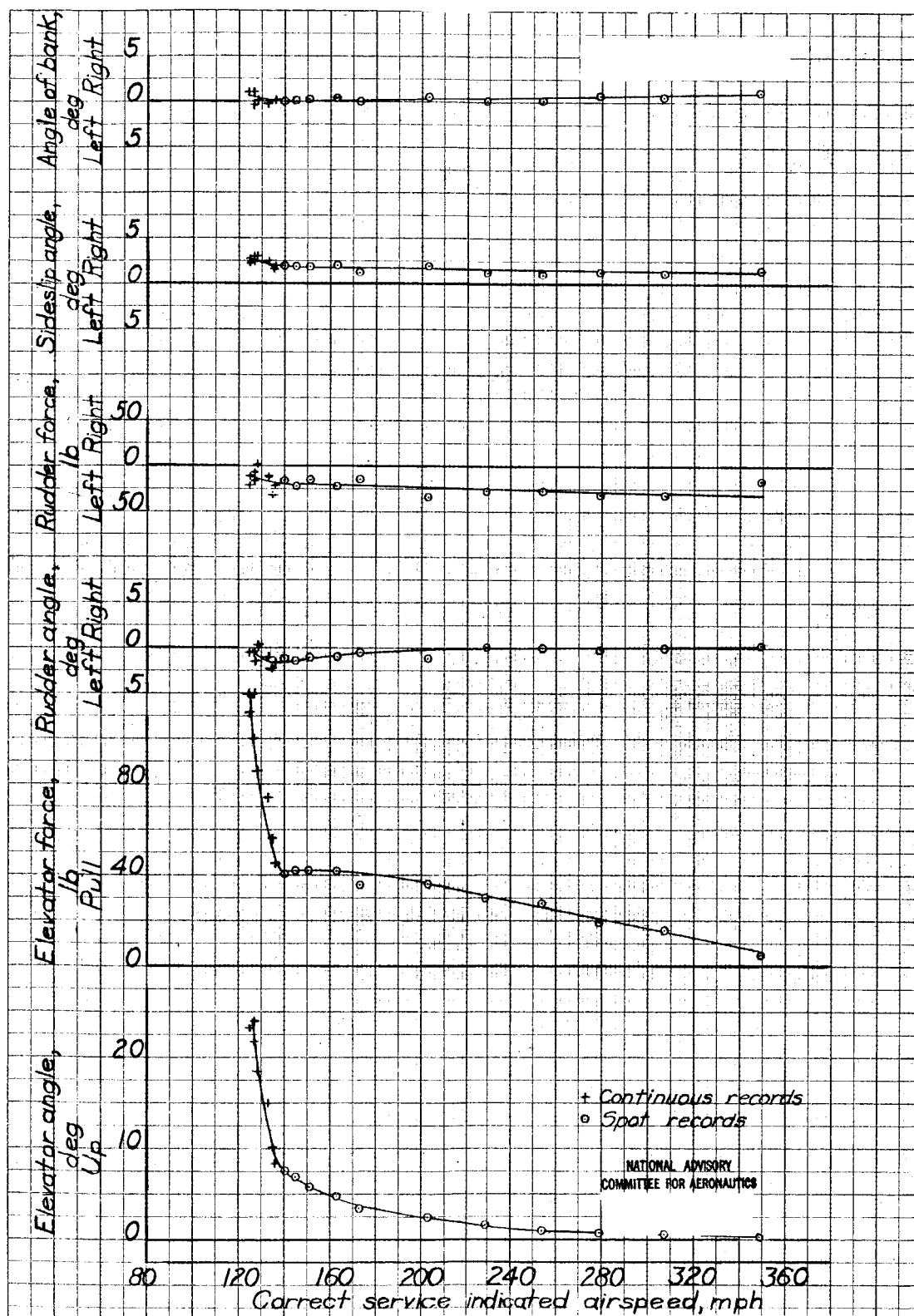
Figure 11.- Continued.





(c) c.g. at 31.9 percent M.A.C., elevator 2° up, rudder tab 0°.

Figure 11.- Concluded.



(a) c.g. at 23.0 percent M.A.C., elevator tab  $1.2^\circ$  up, rudder tab  $0^\circ$ .

Figure 12.- Static longitudinal stability characteristics in the gliding condition (engines idling, at 6000 to 10,000 ft., flaps up, landing gear up) Douglas A-26B airplane.

L-605

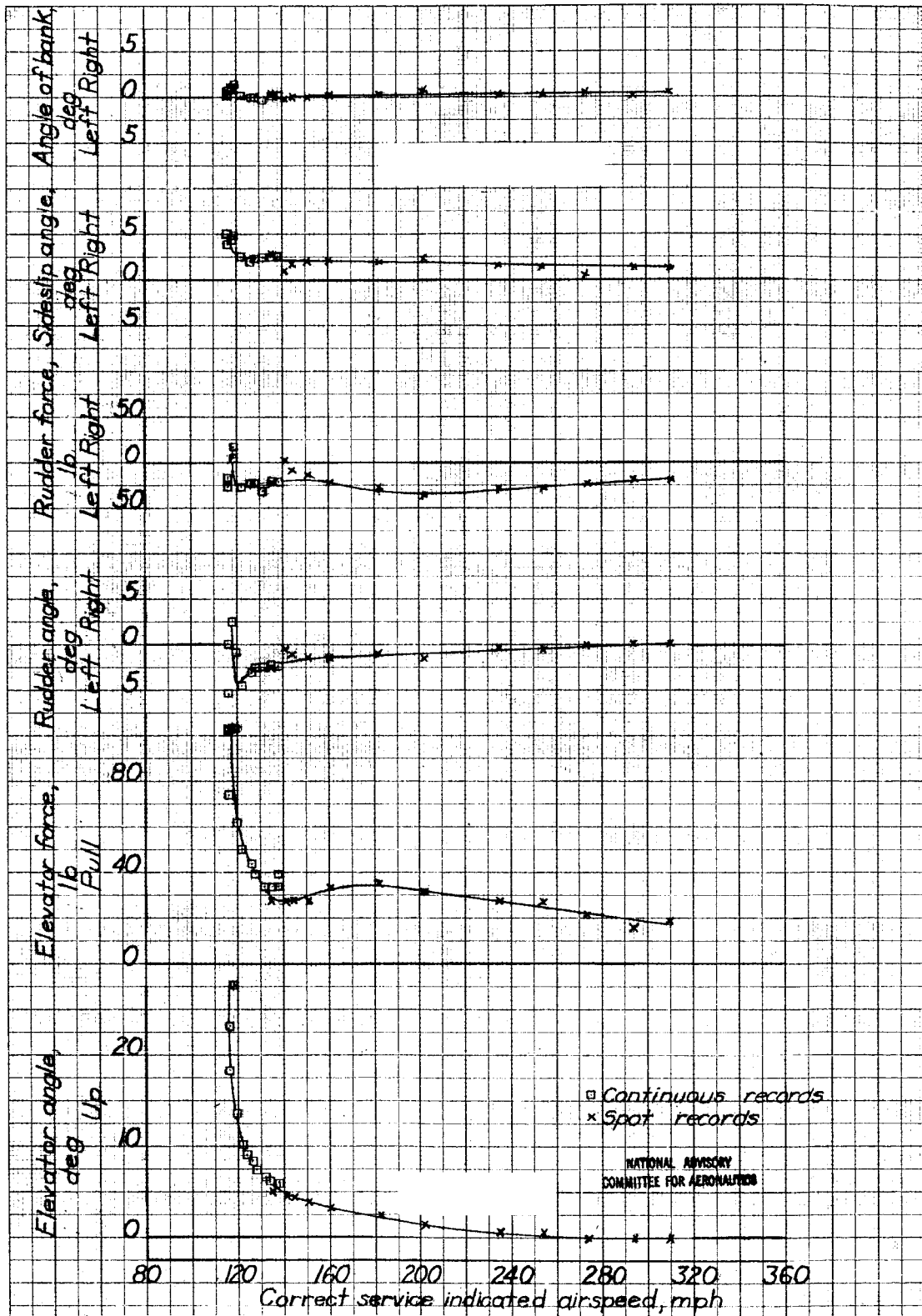
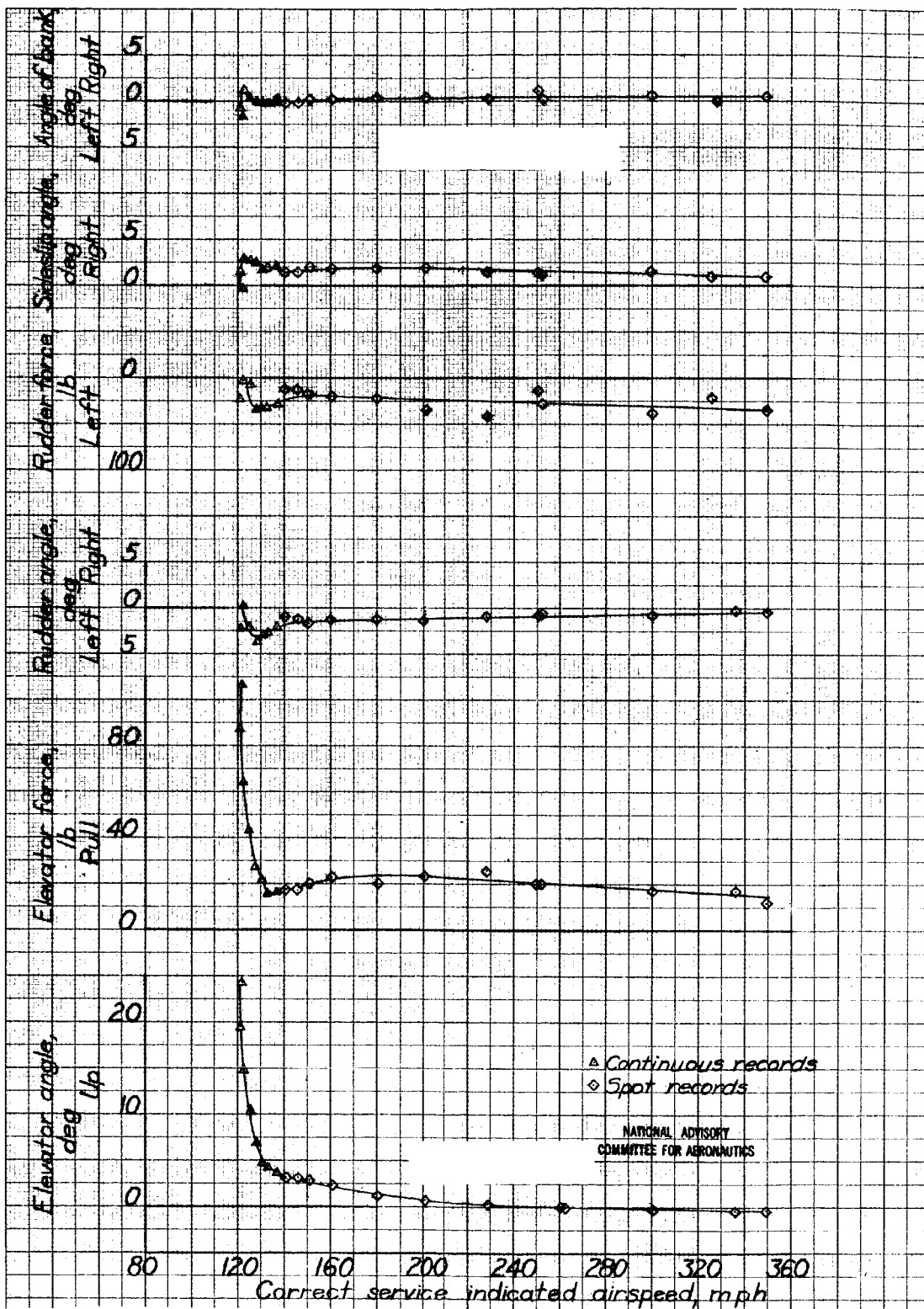
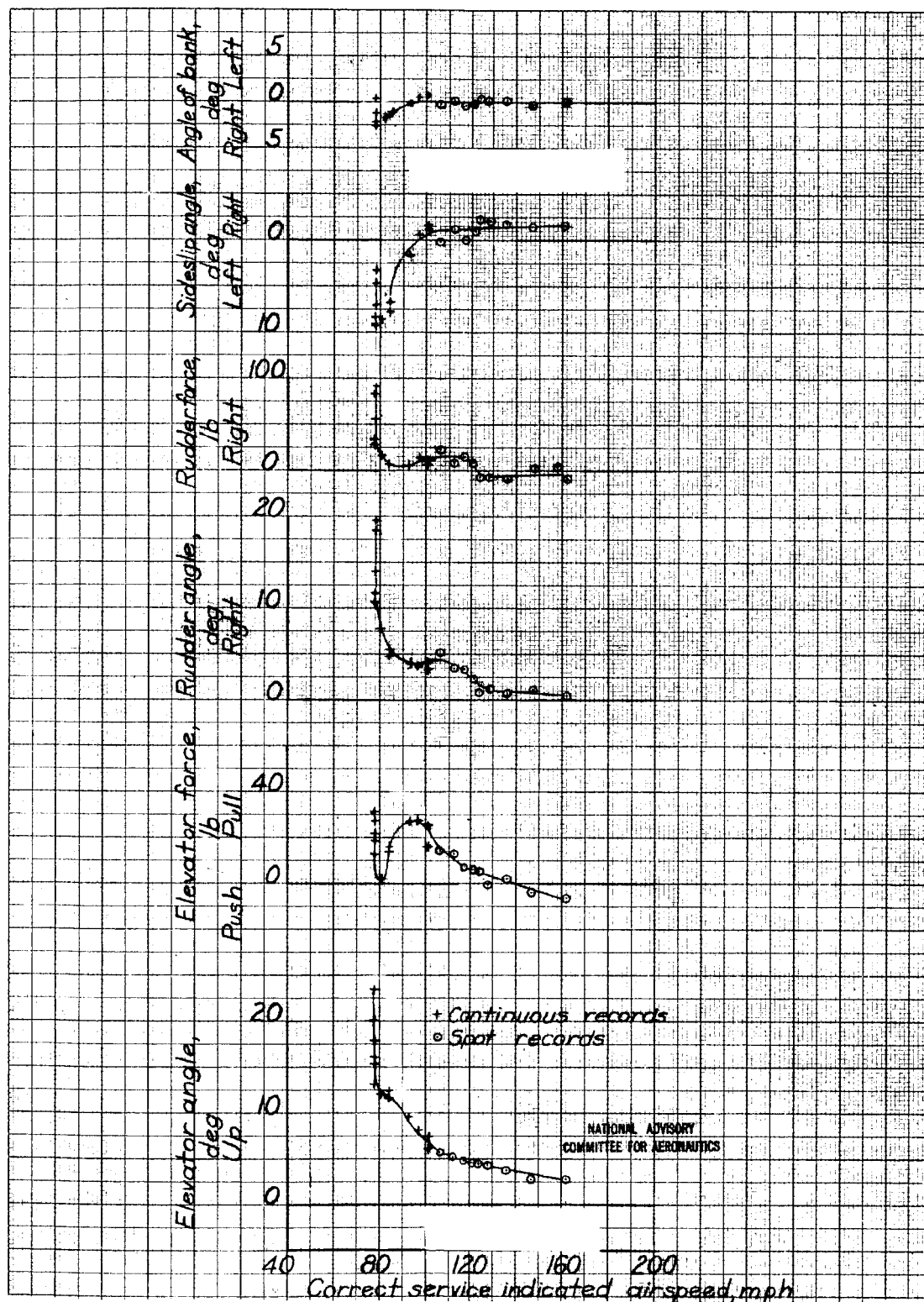
(b) c.g. at 27.4 percent M.A.C., elevator tab  $1.7^\circ$  up, rudder tab  $0.4^\circ$  right.

Figure 12.- Continued.



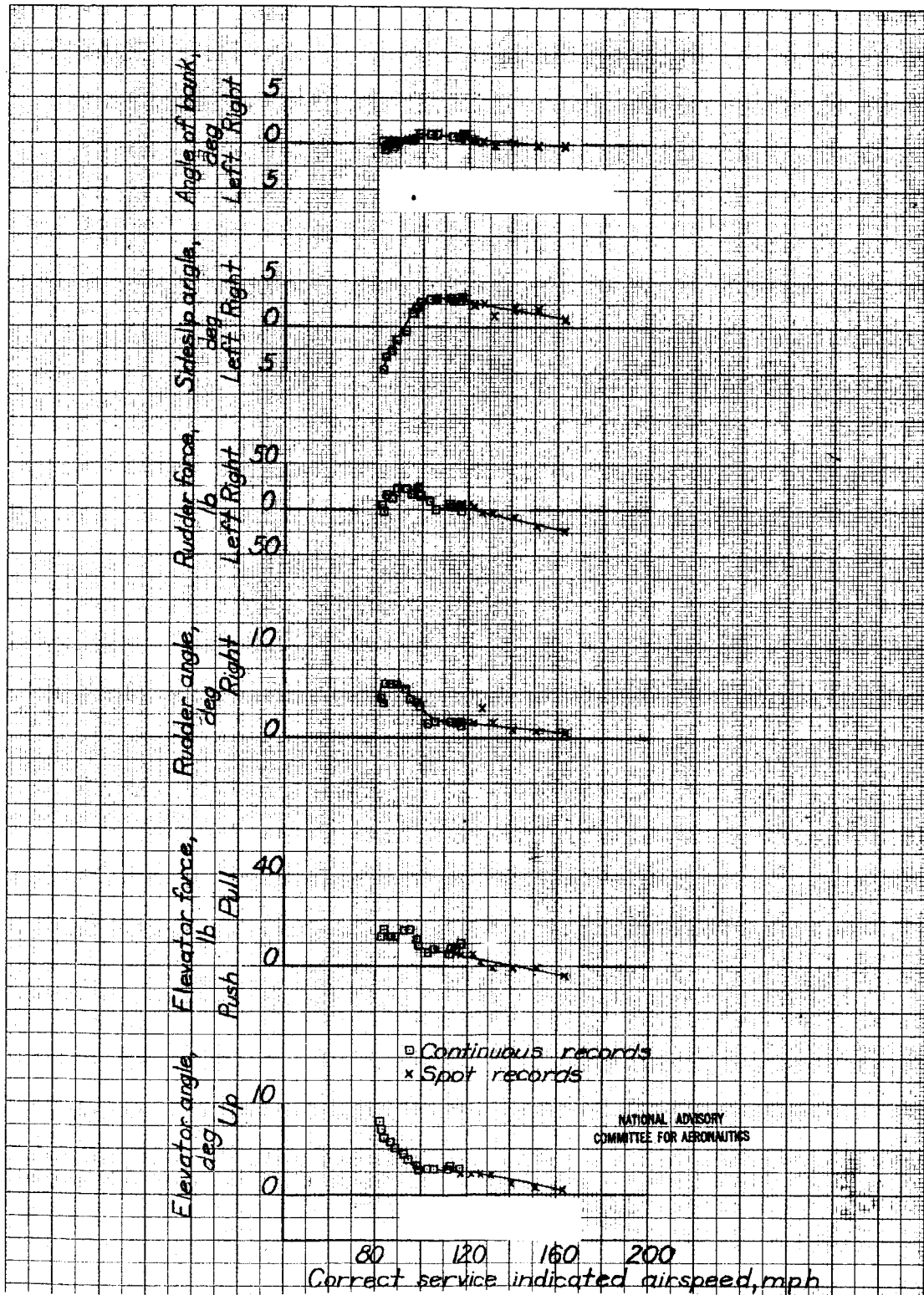
(c) c.g. at 32 percent M.A.C., elevator tab  $23^\circ$  up, rudder tab  $0^\circ$ .

Figure 12.- Concluded.



(a) c.g. at 20.7 percent M.A.C., elevator tab  $9.8^\circ$  down, rudder tab  $0.5^\circ$  right.

Figure 13.- Static longitudinal stability characteristics in the approach condition (30 in. Hg, 2400 rpm at 6000 to 10,000 ft., flaps down, landing gear down), Douglas A-26B airplane.



(b) c.g. at 25.8 percent M.A.C., elevator tab  $3.3^\circ$  down, rudder tab  $0.8^\circ$  left.

Figure 13.- Continued.

L-605

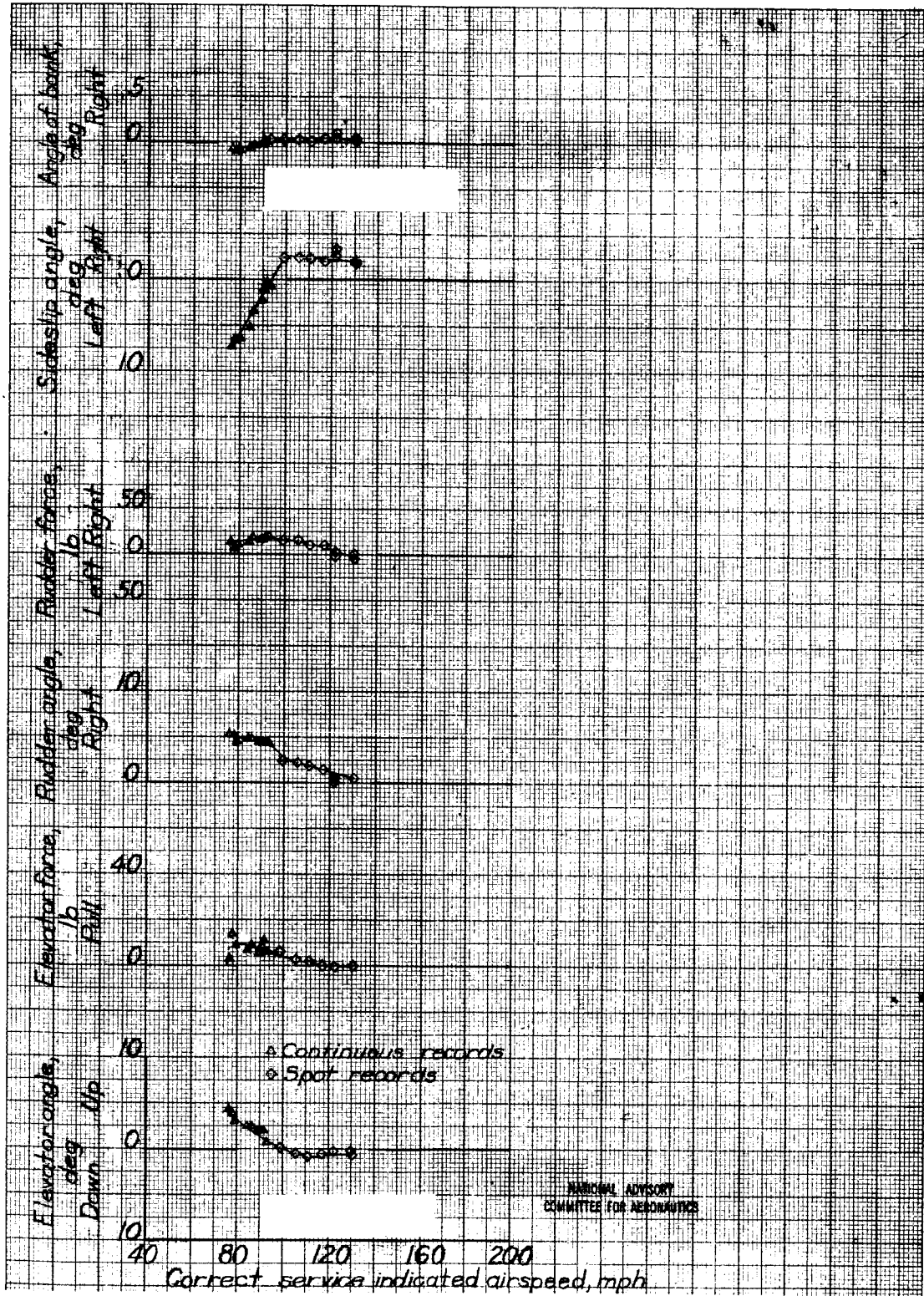
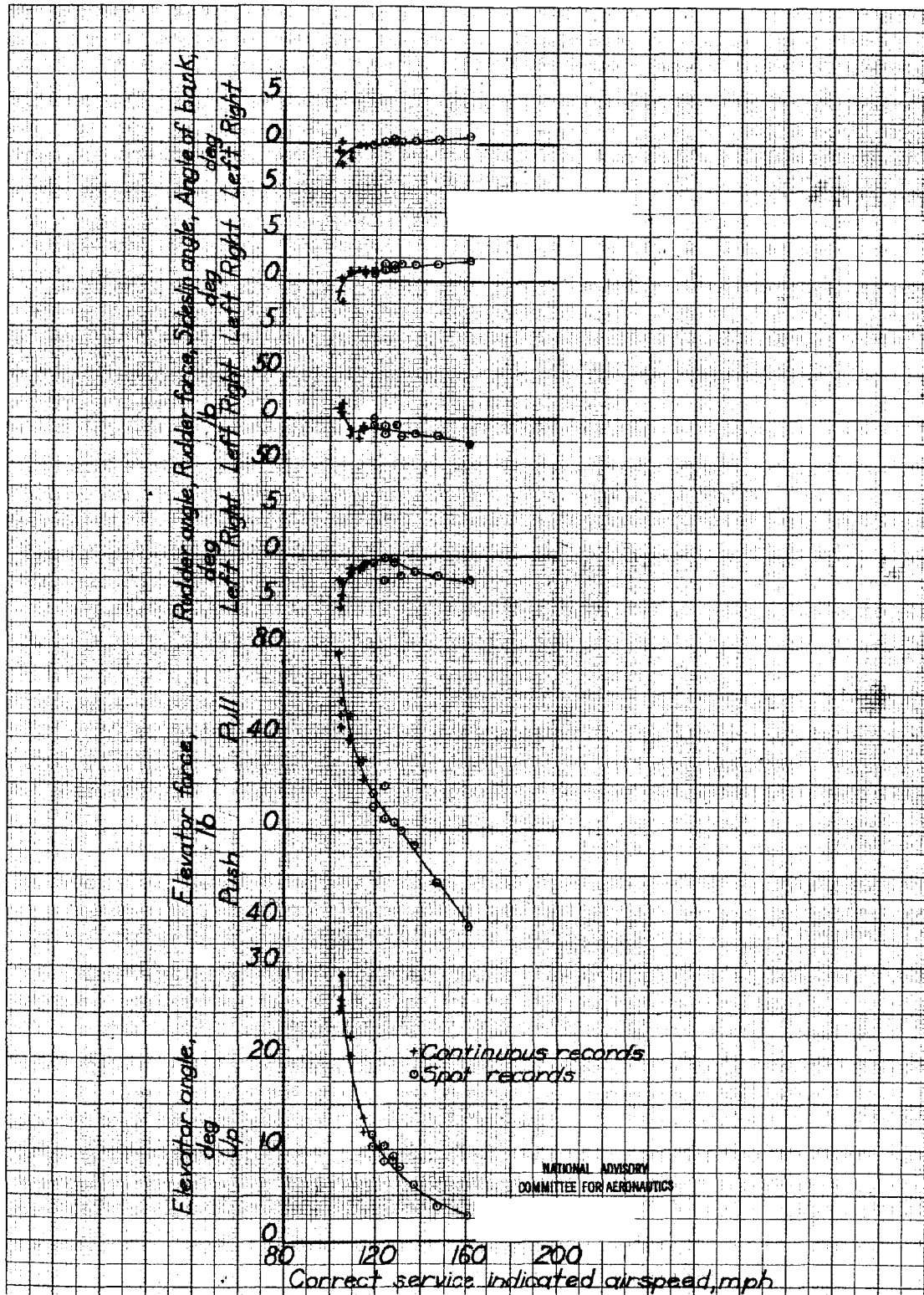
(c) c.g. at 29.9 percent M.A.C., elevator tab  $0.3^\circ$  down, rudder tab  $0.5^\circ$  left.

Figure 13.- Concluded.



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(a) c.g. at 20.8 percent M.A.C., elevator tab  $15.0^\circ$  down, rudder tab  $0.8^\circ$  right.

Figure 14.- Static longitudinal stability characteristics in the landing condition (engines idling, 6000 to 10,000 ft., flaps down, landing gear down), Douglas A-26B airplane.



L-605

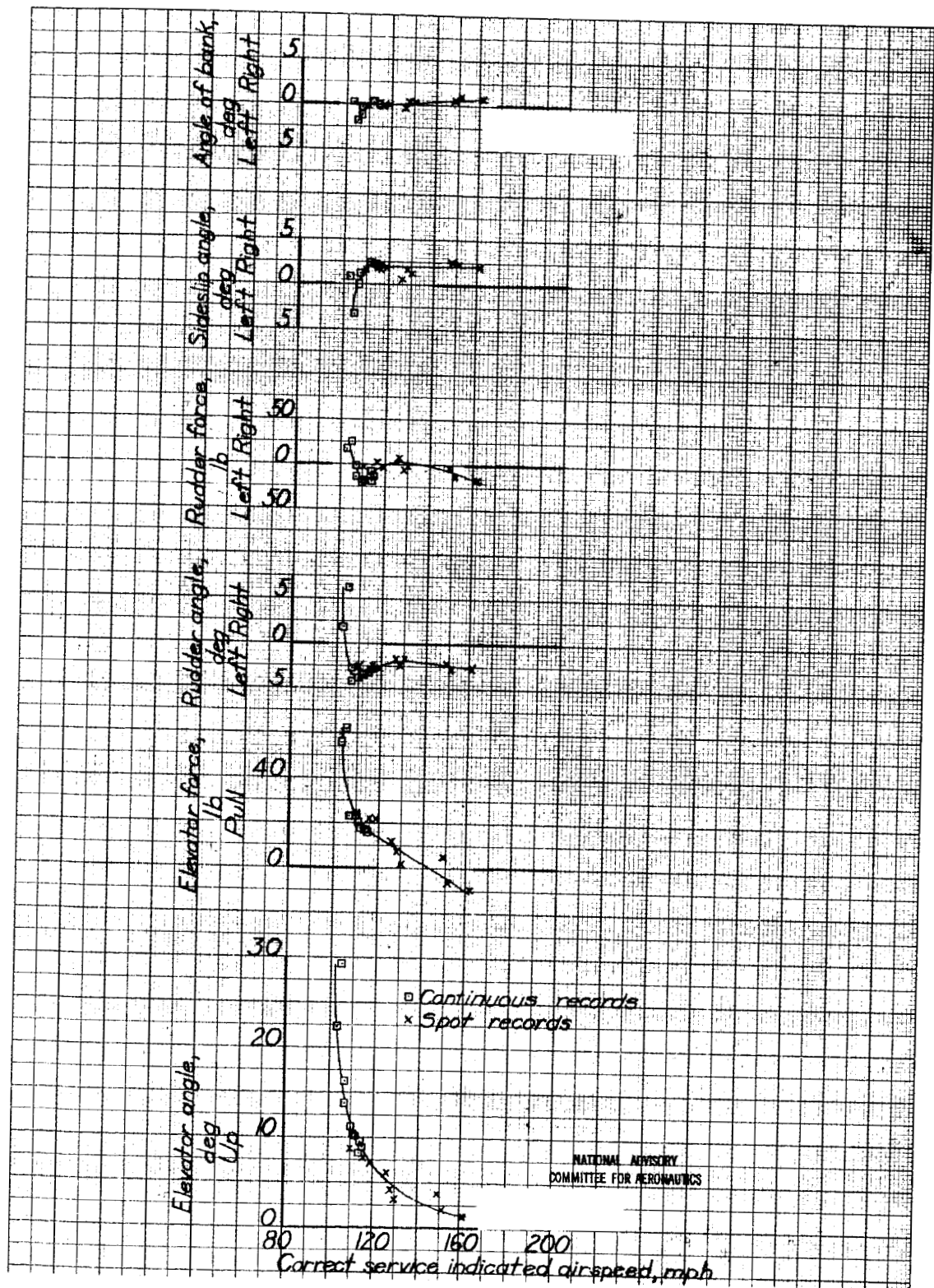
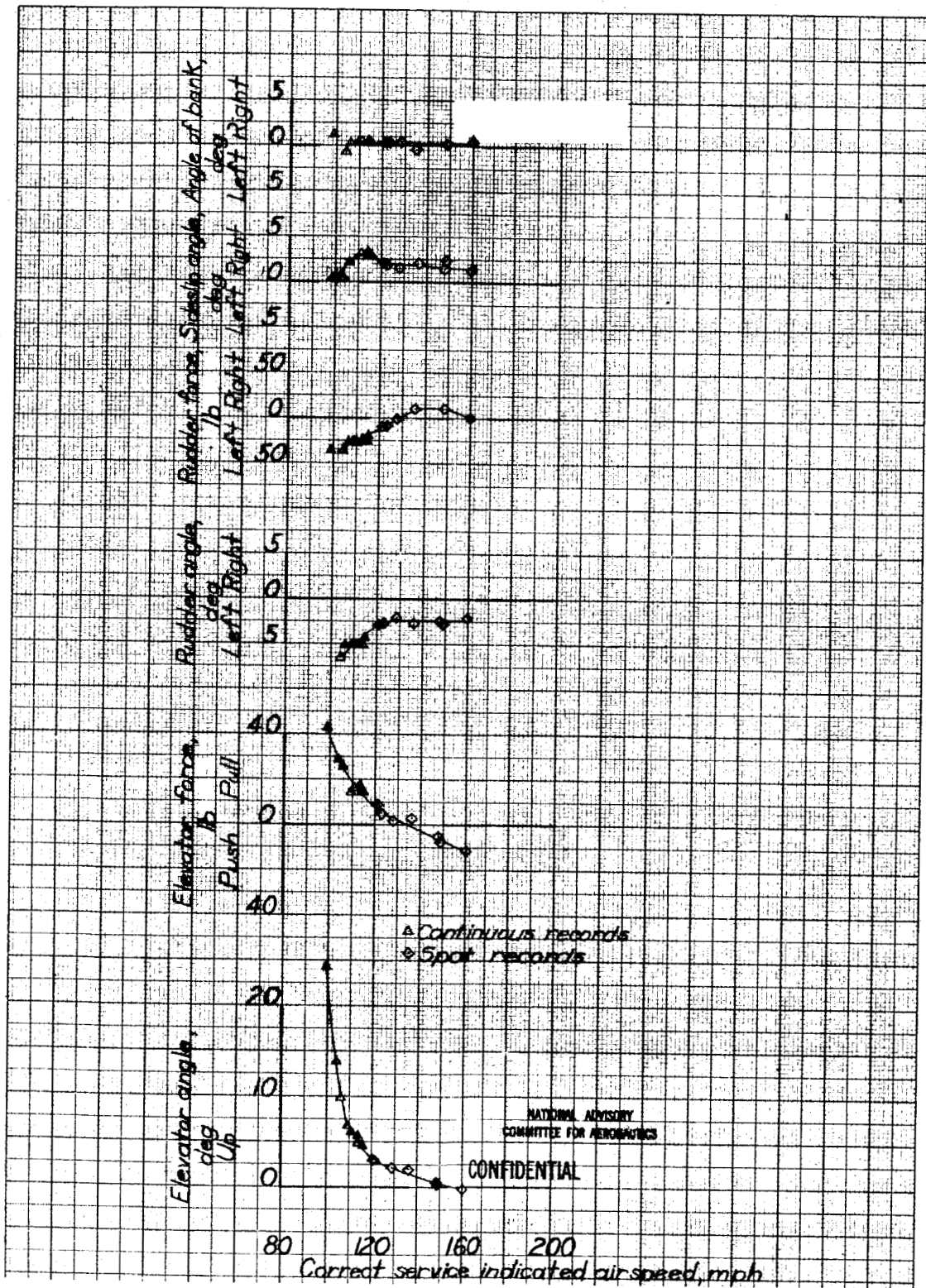
(b) c.g. at 25.9 percent M.A.C., elevator tab  $5.0^\circ$  down, rudder tab  $1.6^\circ$  right.

Figure 14.- Continued.

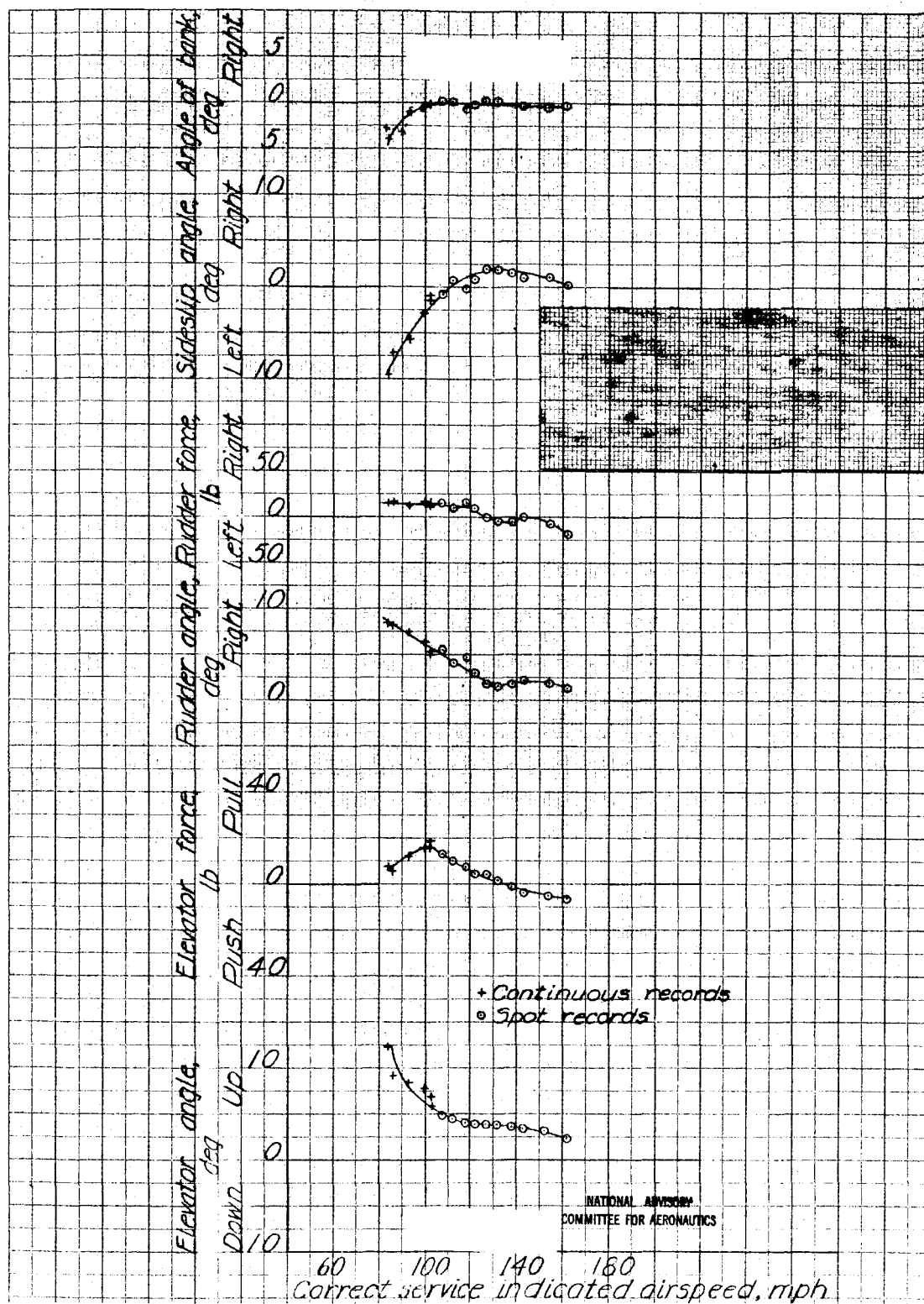
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(c) c.g. at 29.9 percent M.A.C., elevator tab  $2.6^\circ$  down, rudder tab  $1^\circ$  right.

Figure 14.- Concluded.

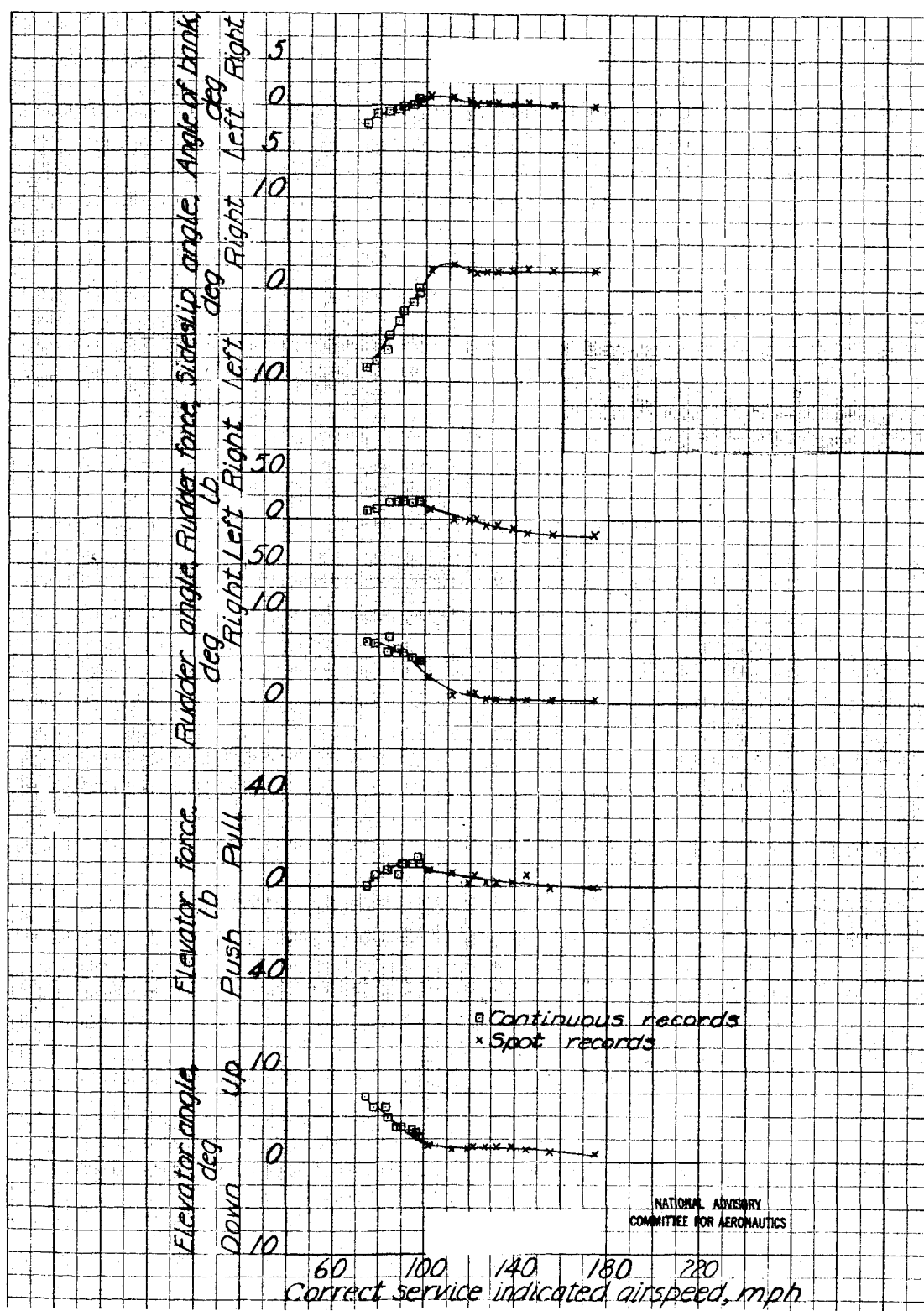
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(a) c.g. at 20.8 percent M.A.C. elevator tab  $8.7^\circ$  down, rudder tab  $0.8^\circ$  left.

Figure 15.- Static longitudinal stability characteristics in the wave off condition (41.5 in. Hg, 2400 rpm at 6000 to 10,000 ft., flaps down, landing gear down), Douglas A-26B airplane.

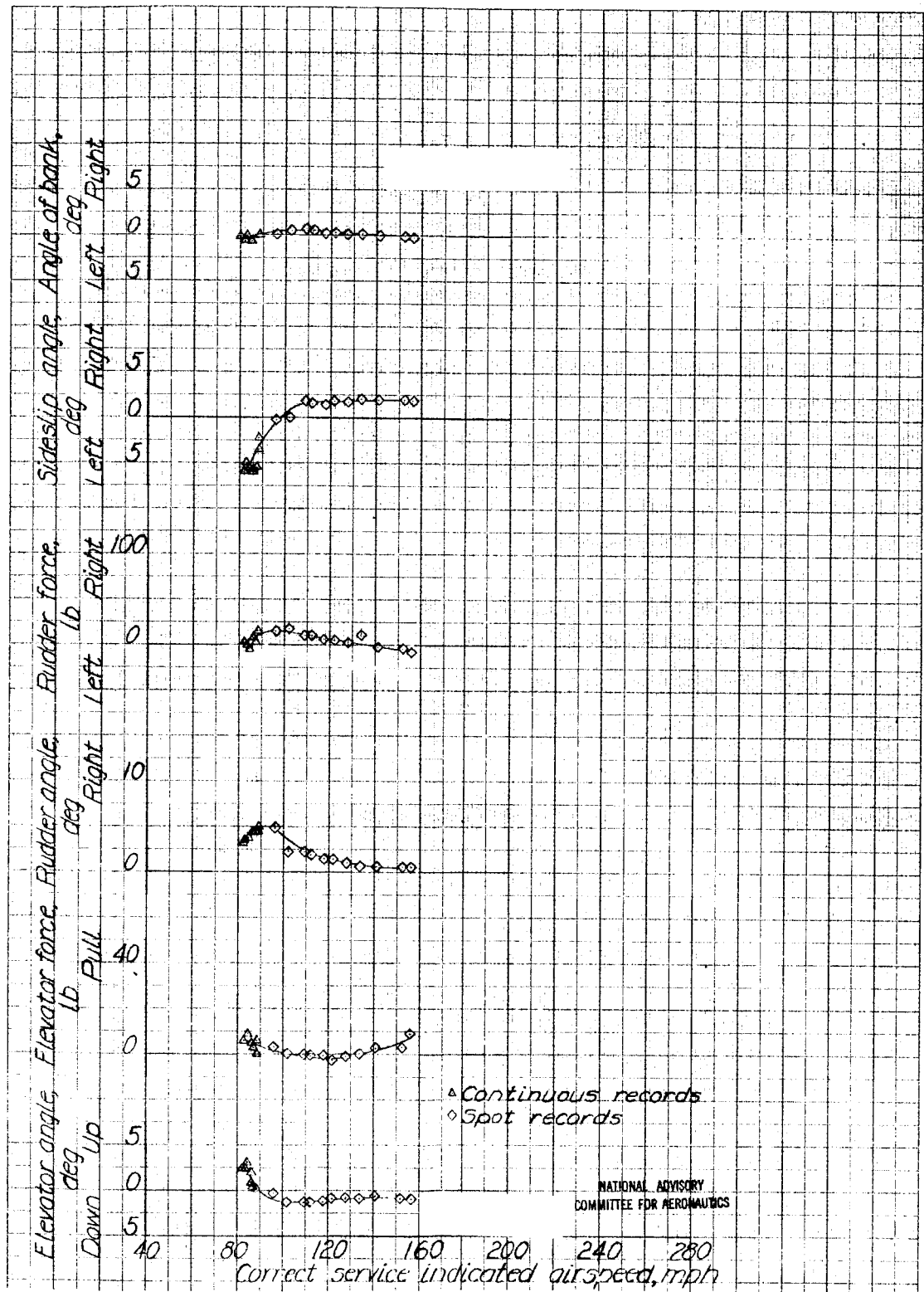
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(b) c.g. at 25.5 percent M.A.C., elevator tab 4.0° down, rudder tab 0.5° left.

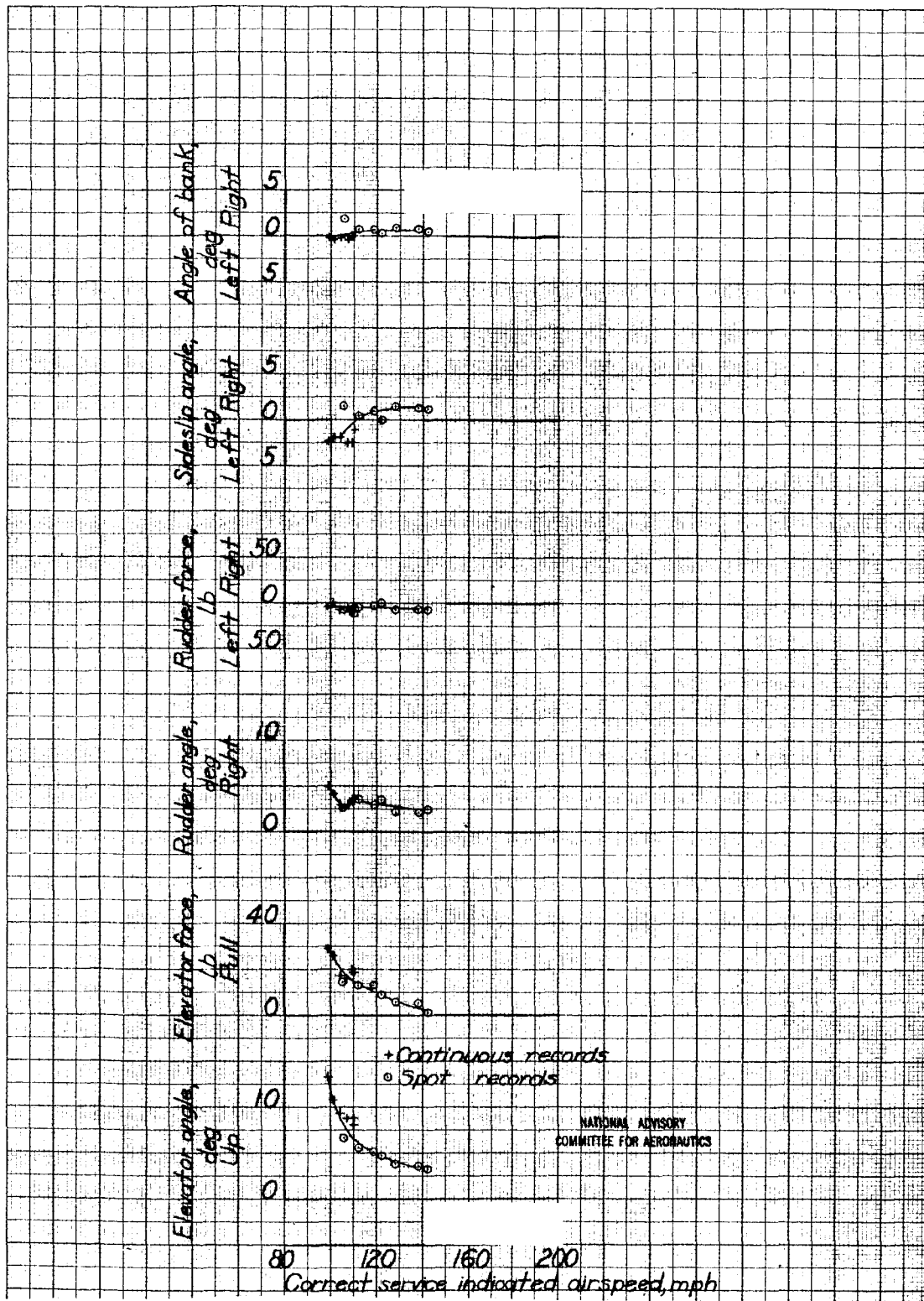
Figure 15.- Continued.

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(c) c.g. at 29.3 percent M.A.C., elevator tab 0.1° up, rudder tab 0.5° left.

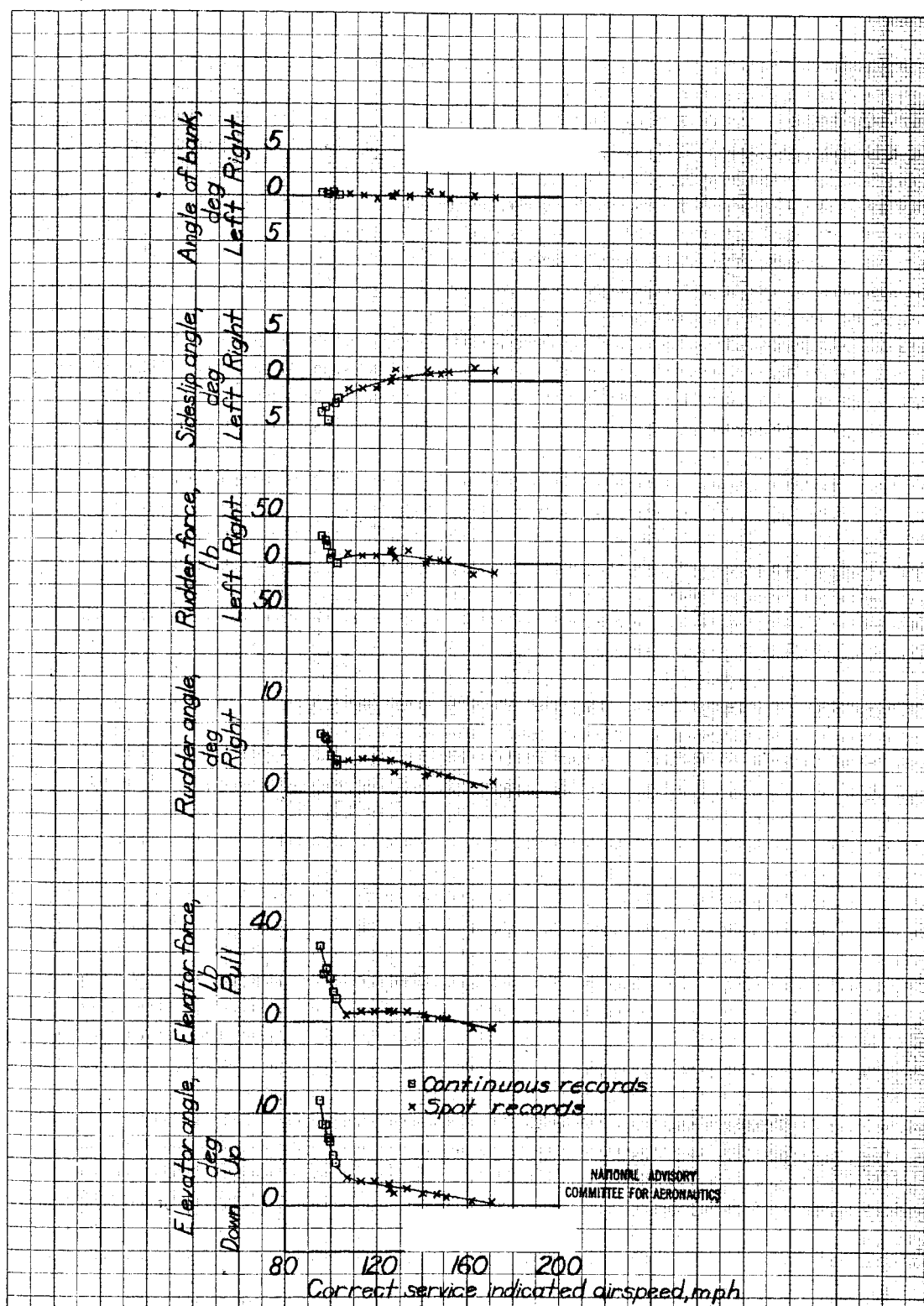
Figure 15.- Concluded.



(a) c.g. at 21.3 percent M.A.C., elevator tab  $4.3^\circ$  down, rudder tab  $0.1^\circ$  left.

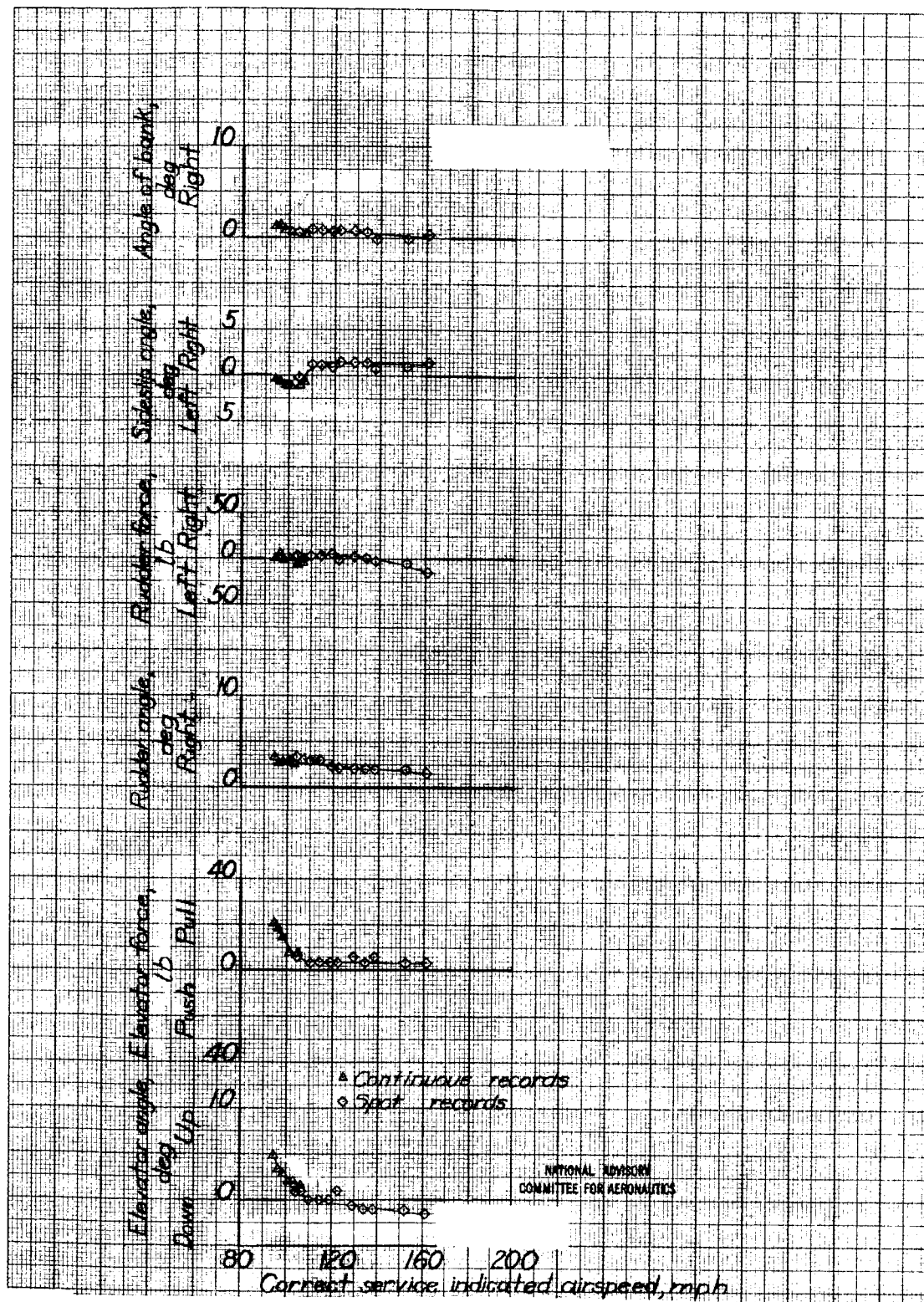
Figure 16.- Static longitudinal stability characteristics in the take-off condition (41.5 in. H<sub>r</sub>, 2400 rpm at 6000 to 10,000 ft., flaps down, landing gear down), Douglas A-26B airplane.





(b) c.g. at 25.8 percent M.A.C., elevator tab  $1.2^\circ$  down, rudder tab  $0.8^\circ$  left.

Figure 16.- Continued.



(c) c.g. at 30.0 percent M.A.C., elevator tab  $1.9^\circ$  up, rudder tab  $1.2^\circ$  left.

Figure 16.- Concluded.



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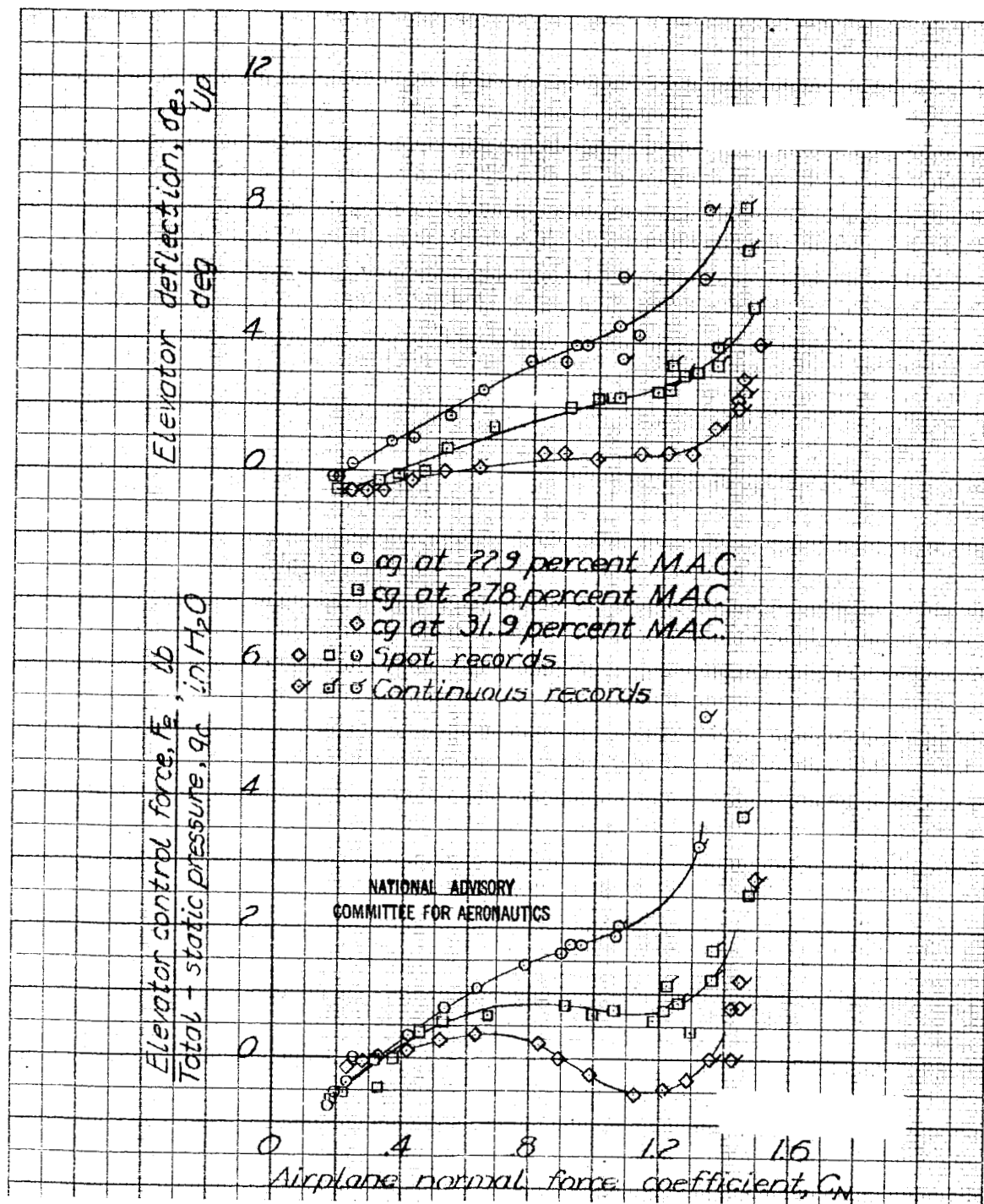


Figure 17.- Variation of elevator deflection and elevator control force divided by  $q_c$  with airplane normal-force coefficient for three center-of-gravity positions in the cruising condition, Douglas A-26B airplane.

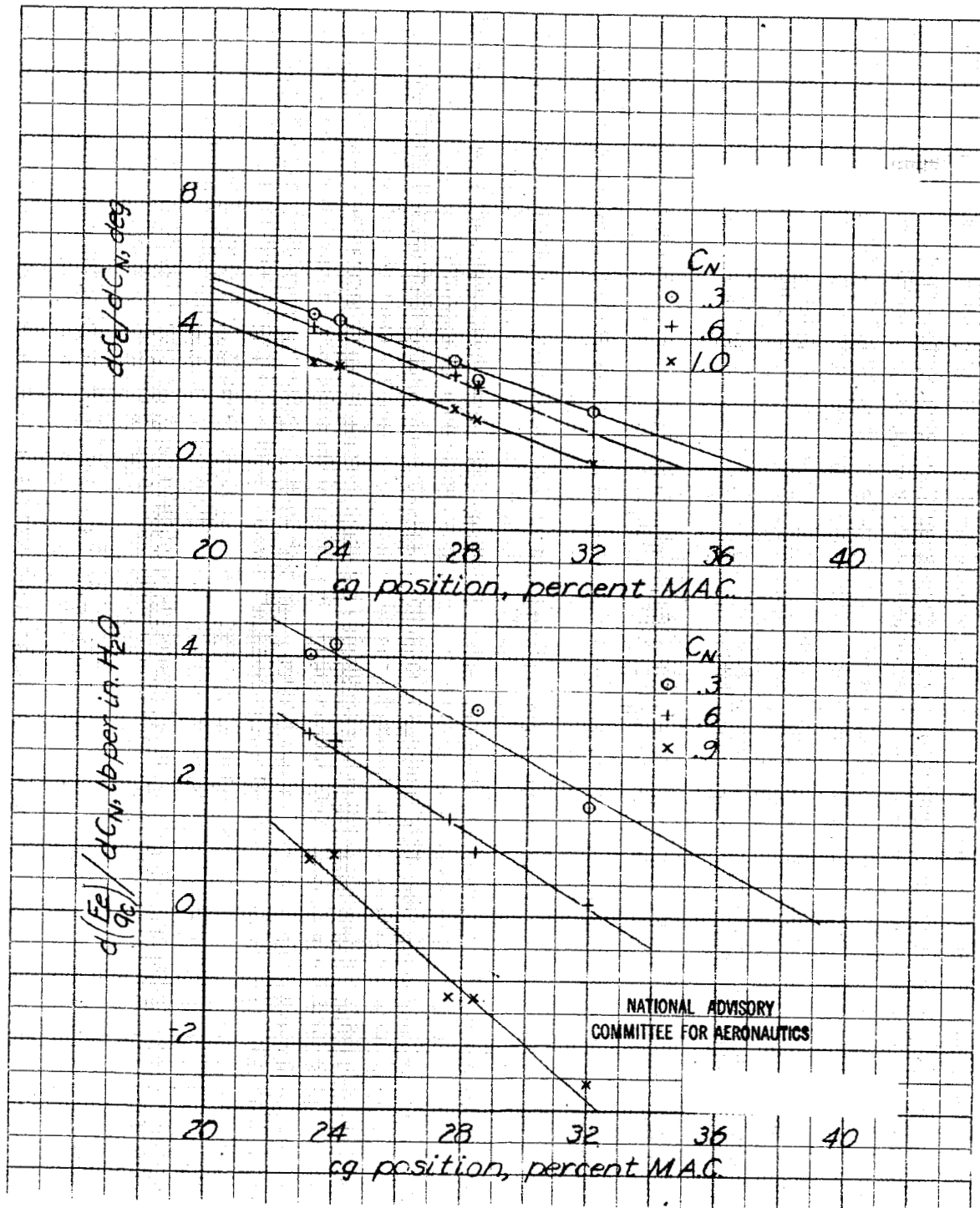


Figure 18.- Determination of neutral points in the rated-power, clean condition, Douglas A-26B airplane.

L-605

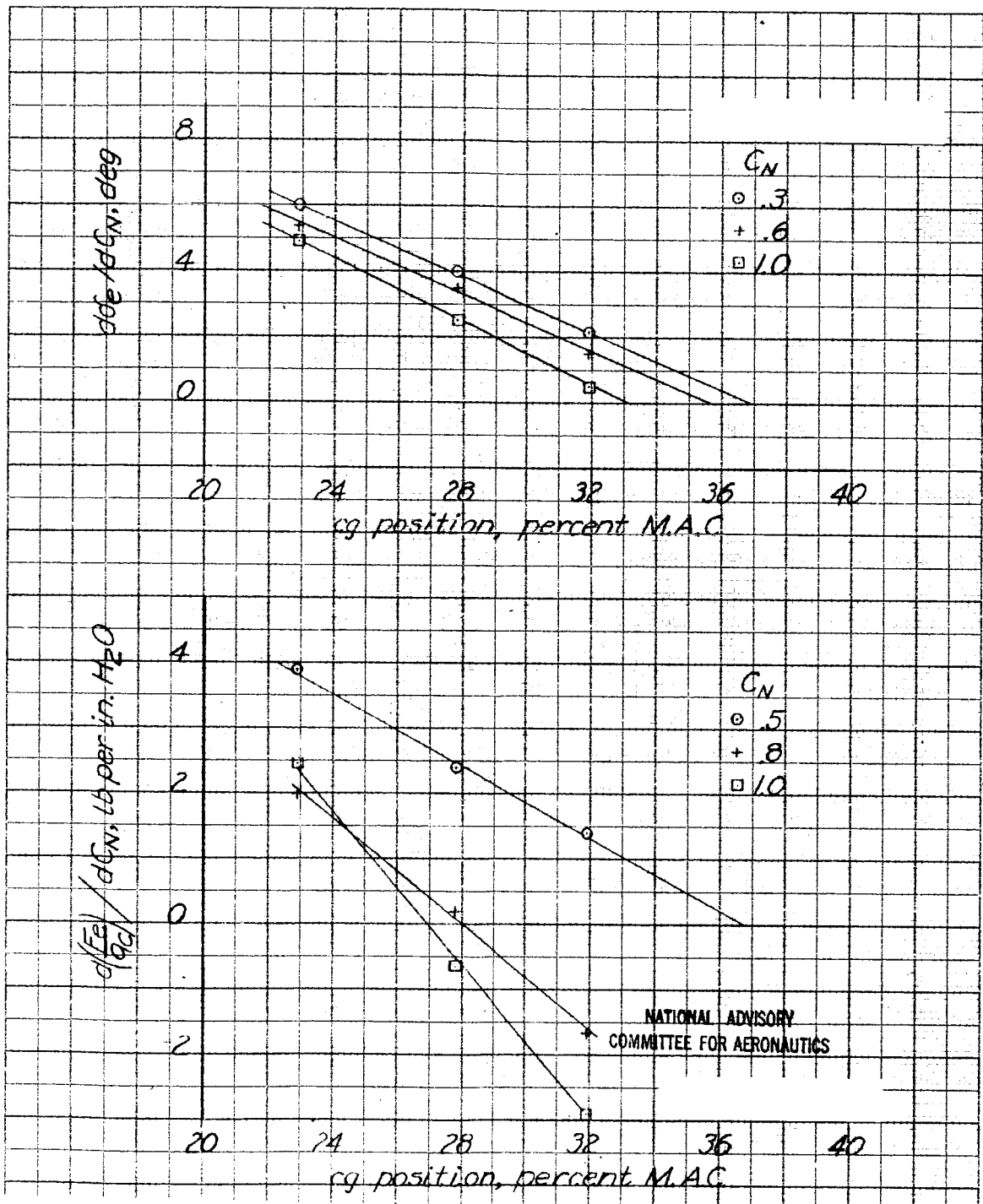


Figure 19.- Determination of neutral points in the cruising condition, Douglas A-26B airplane.

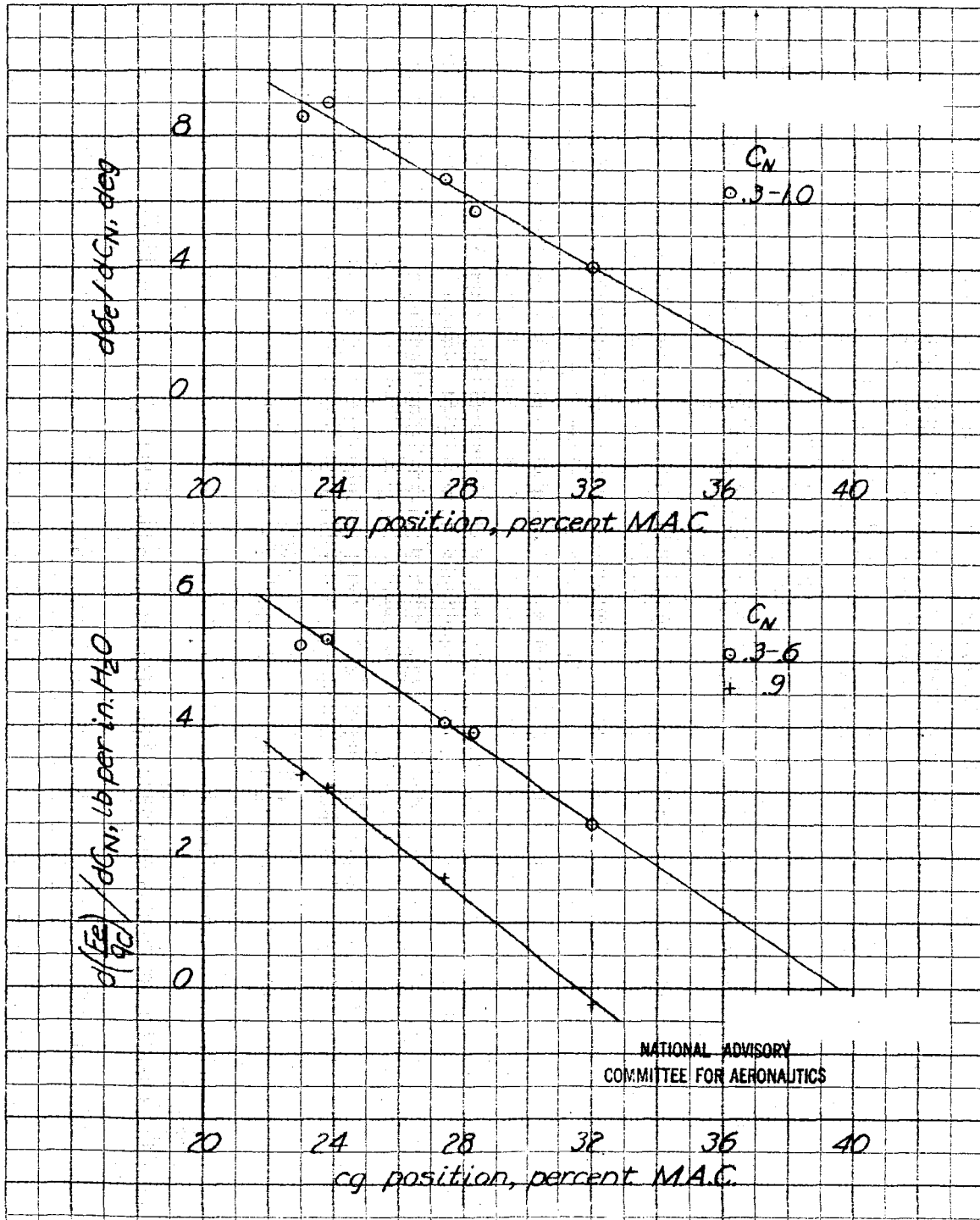


Figure 20.- Determination of neutral points in the gliding condition, Douglas A-26B airplane.

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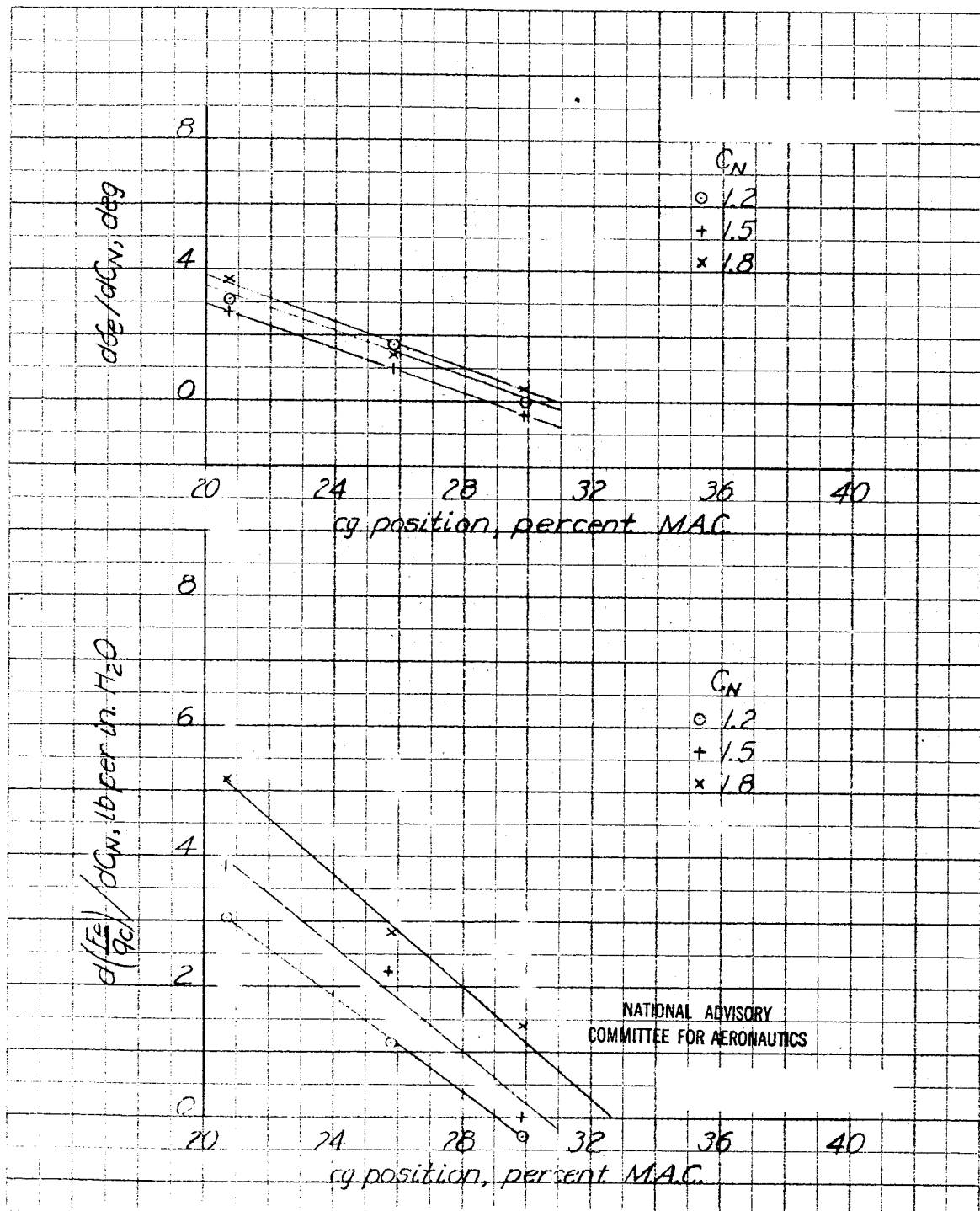


Figure 21.- Determination of neutral points in the approach condition, Douglas A-26B airplane.

L-605

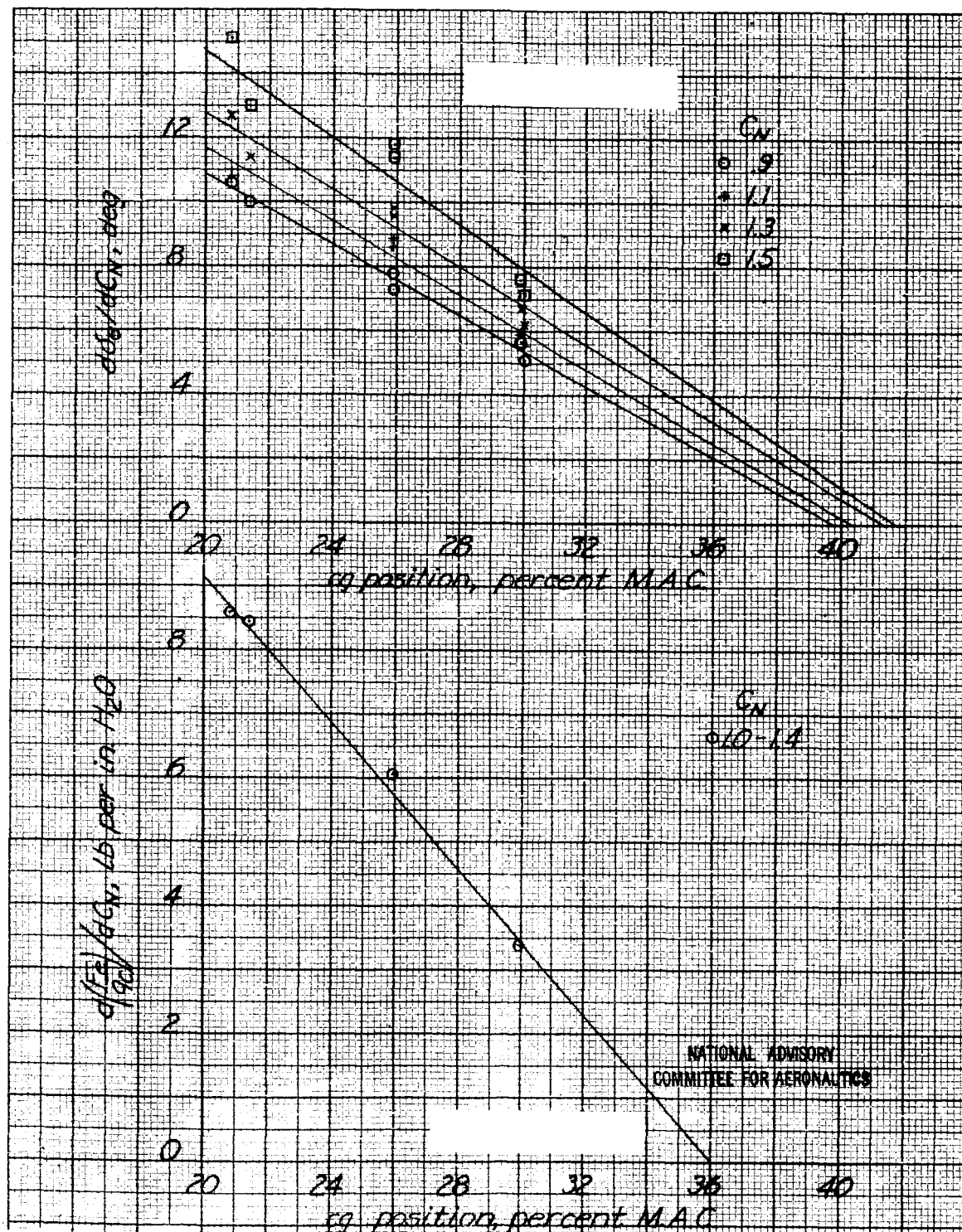


Figure 22.- Determination of neutral points in the landing condition, Douglas A-26B airplane.

L-605

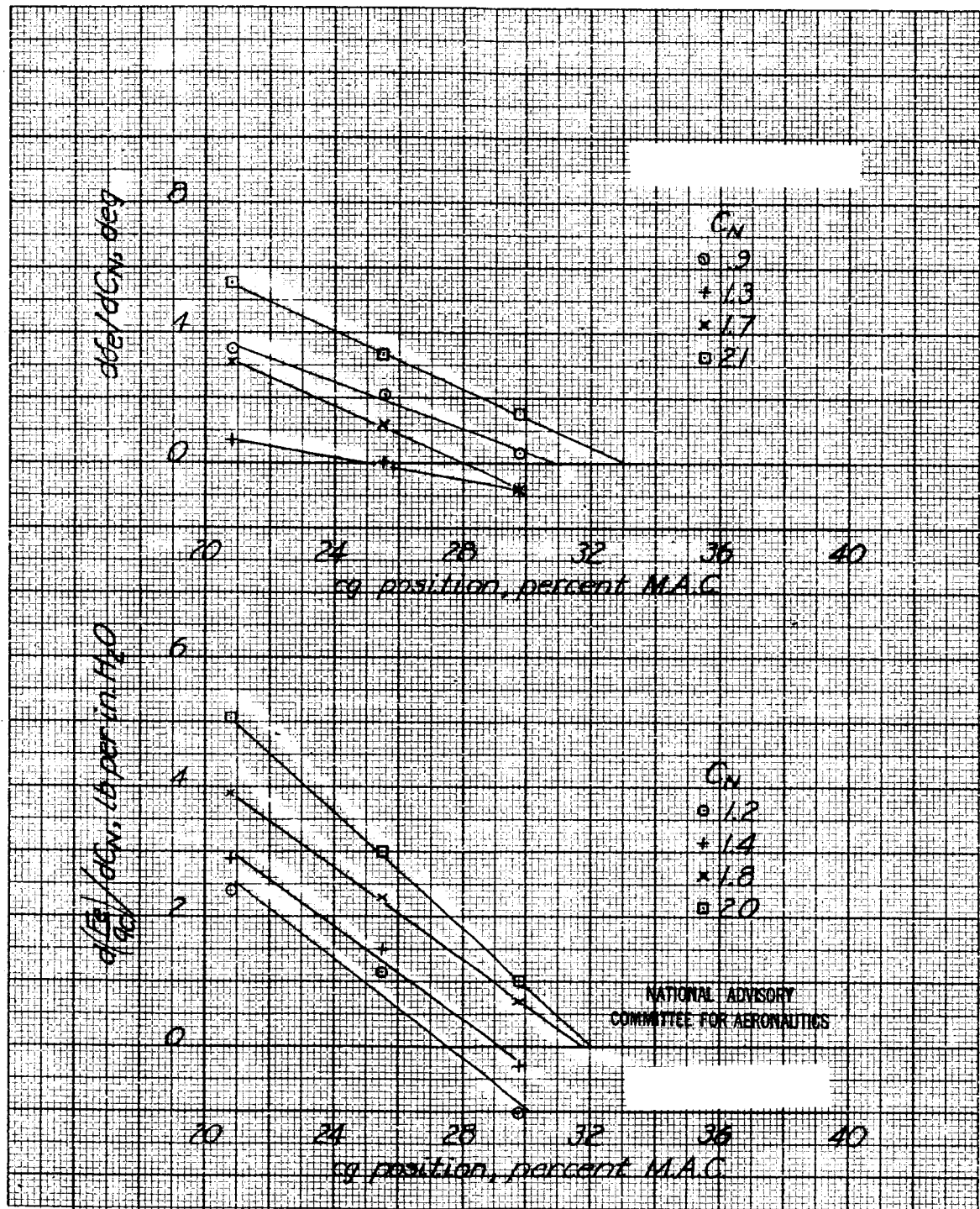


Figure 23.- Determination of neutral points in the wave-off condition, Douglas A-26B airplane.



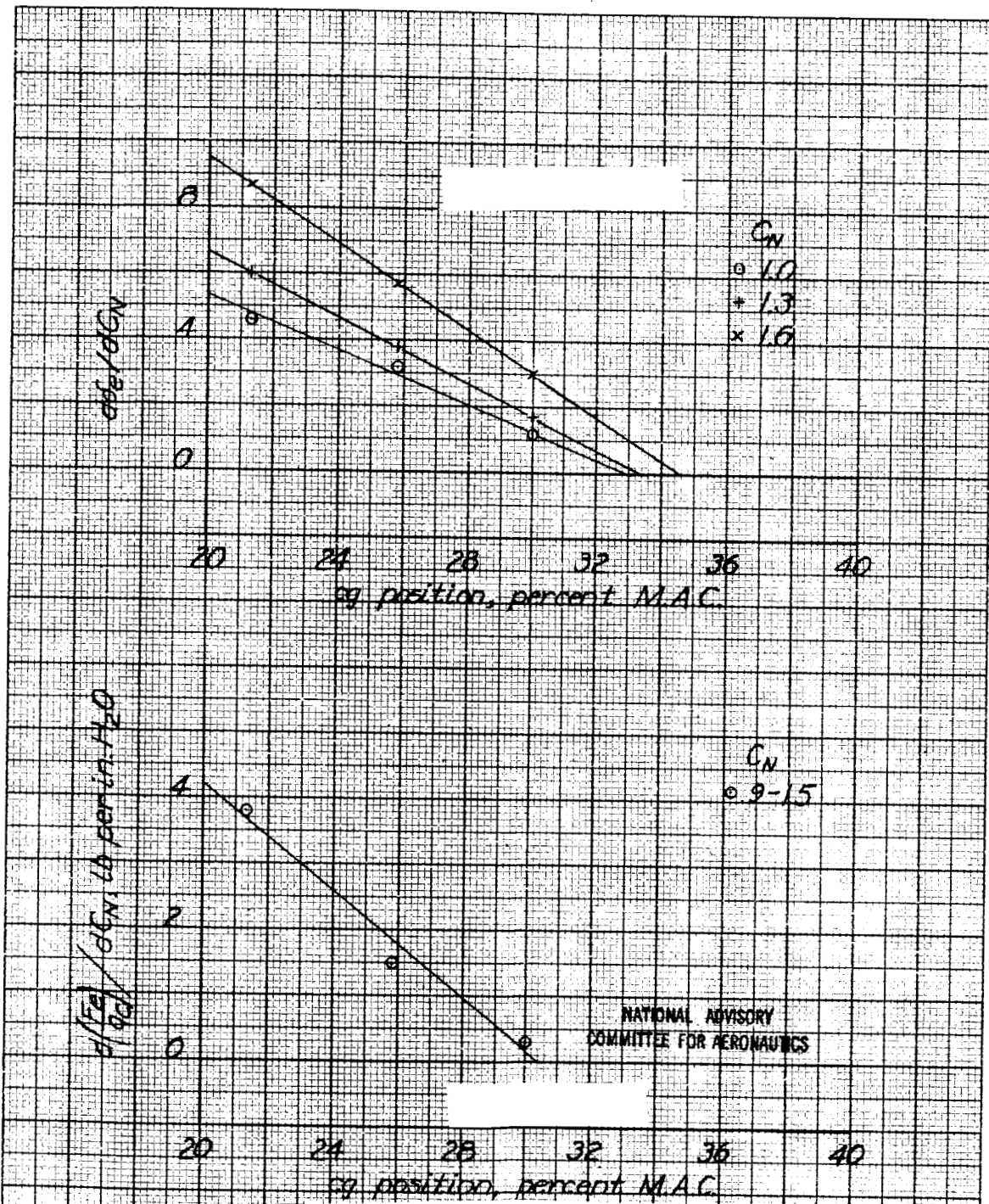


Figure 24.- Determination of neutral points in the take-off condition (rated power, 1/3 flap), Douglas A-26B airplane.



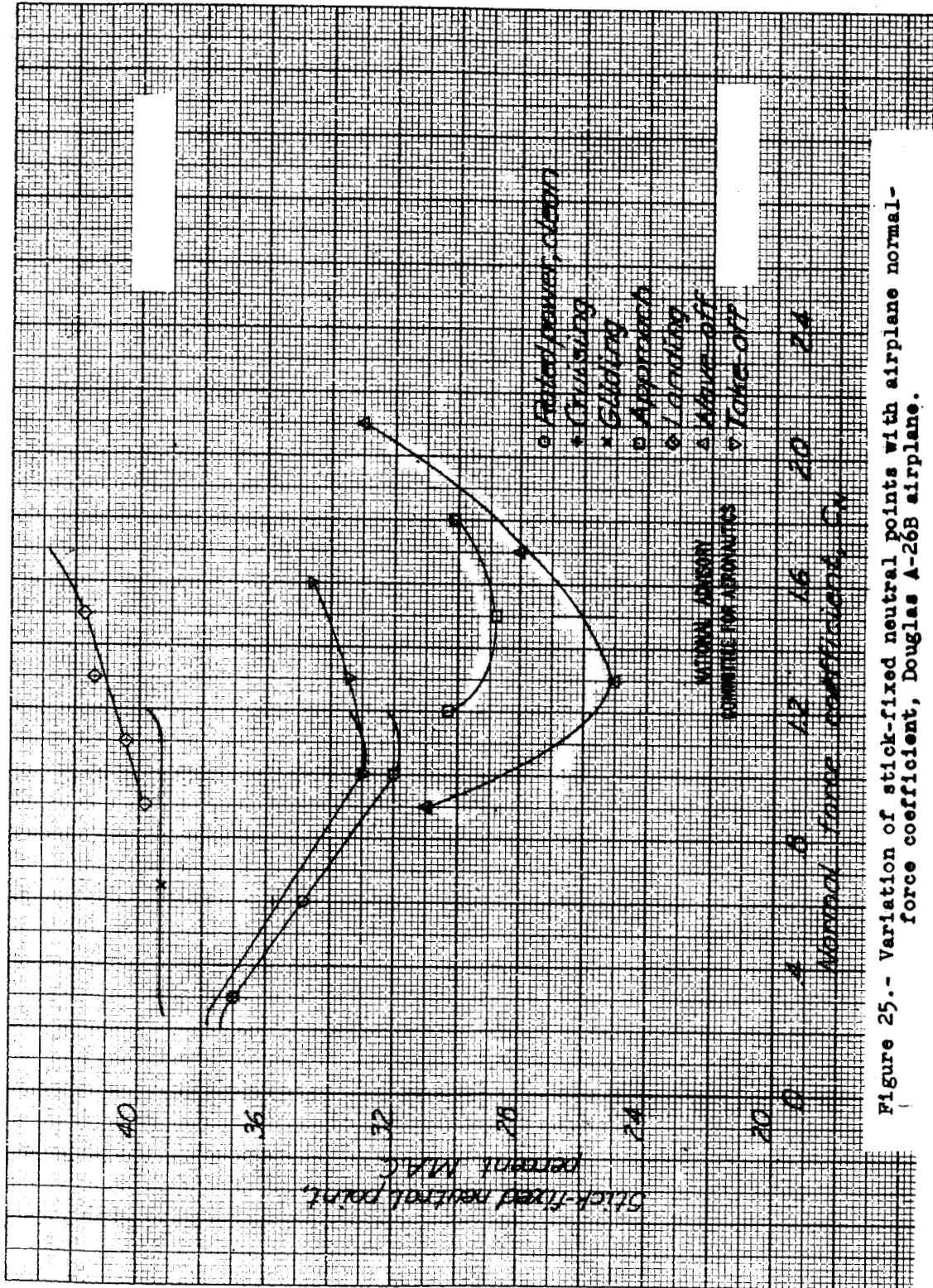


Figure 25.- Variation of stick-fixed neutral points with airframe normal force coefficient, Douglas A-26B airplane.

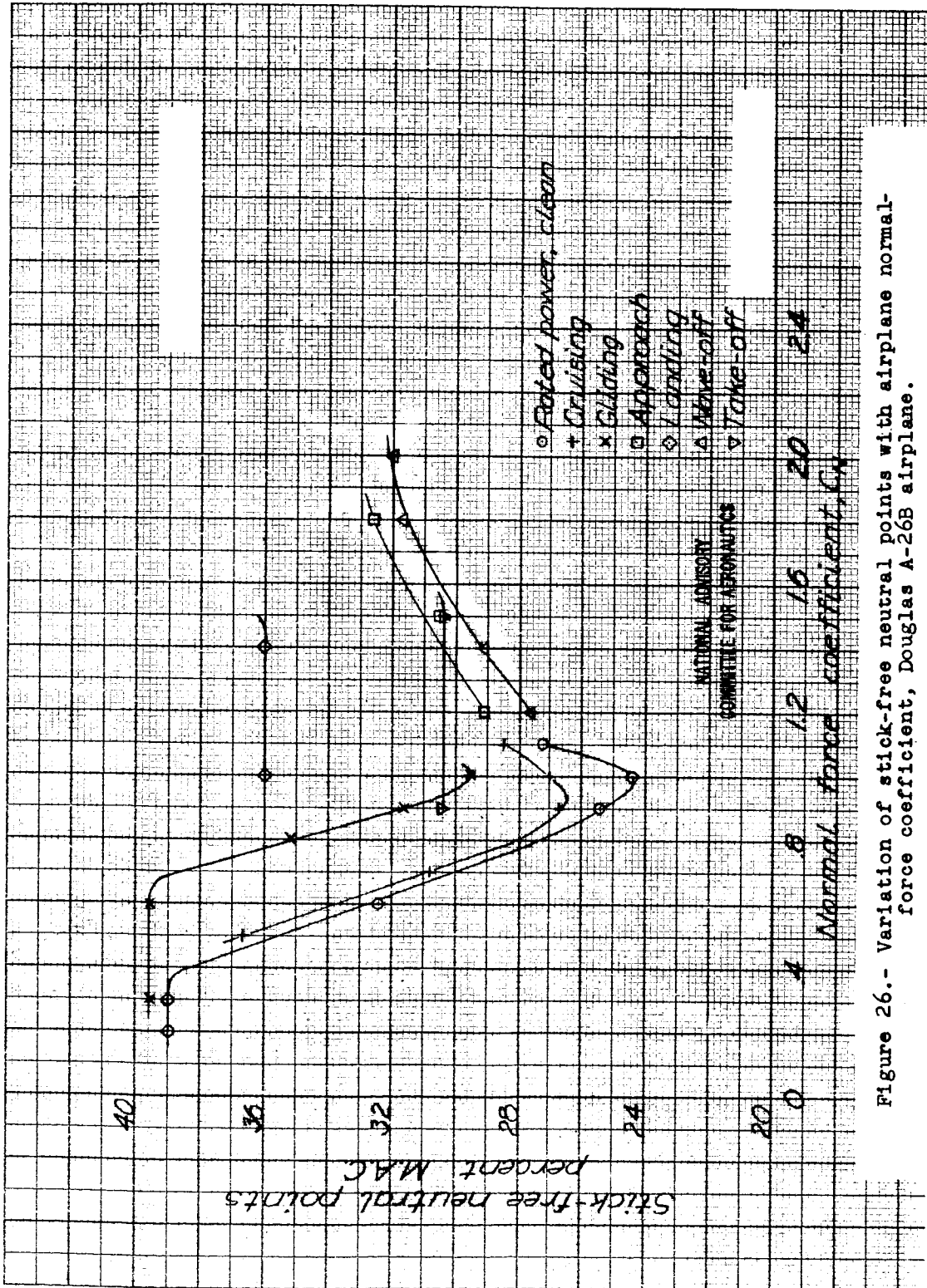


Figure 26.- Variation of stick-free neutral points with airplane normal force coefficient, Douglas A-26B airplane.

L-605

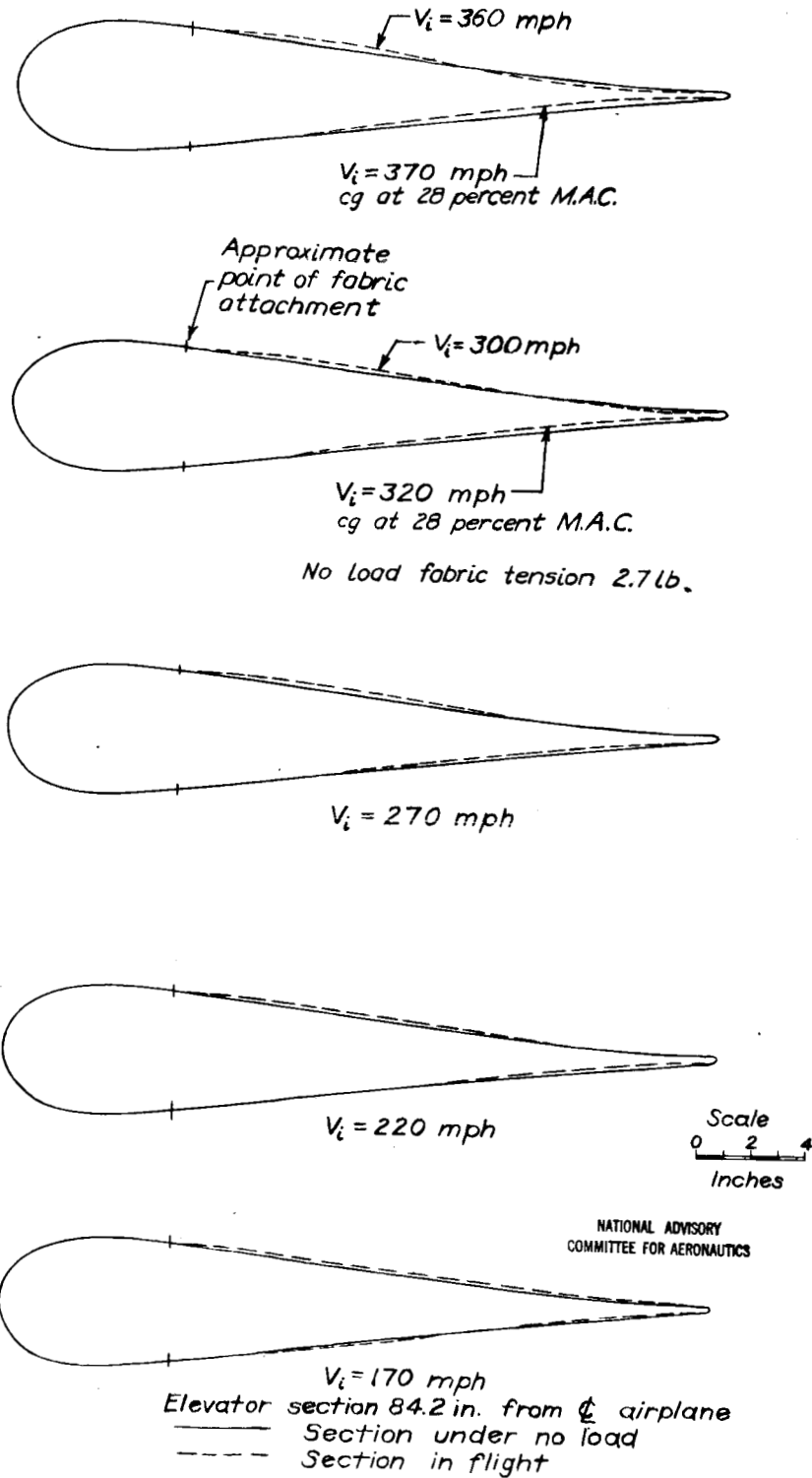
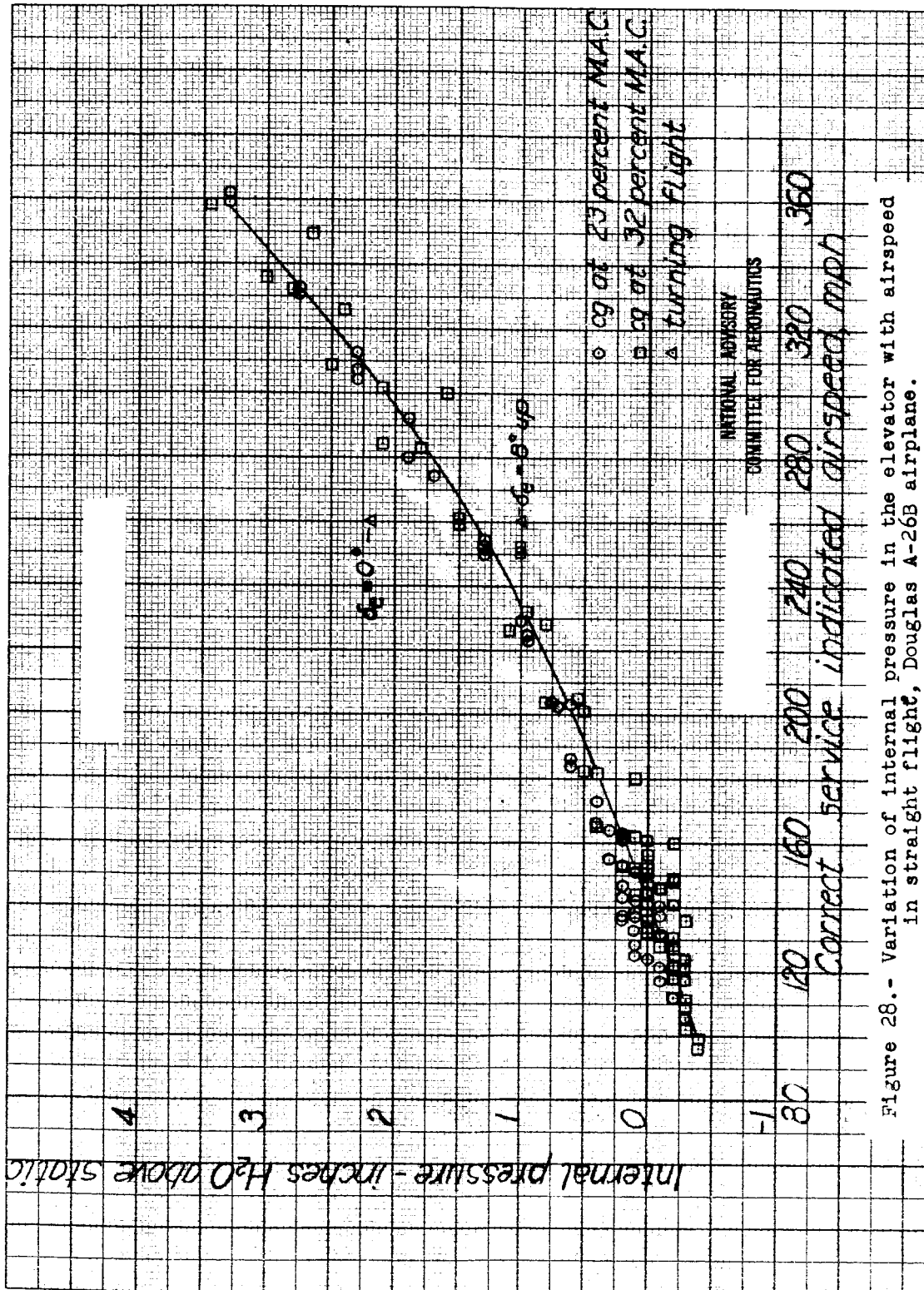


Figure 27.- Elevator fabric distortion at various indicated airspeeds, Douglas A-26B airplane with center of gravity at 32 percent except where noted.



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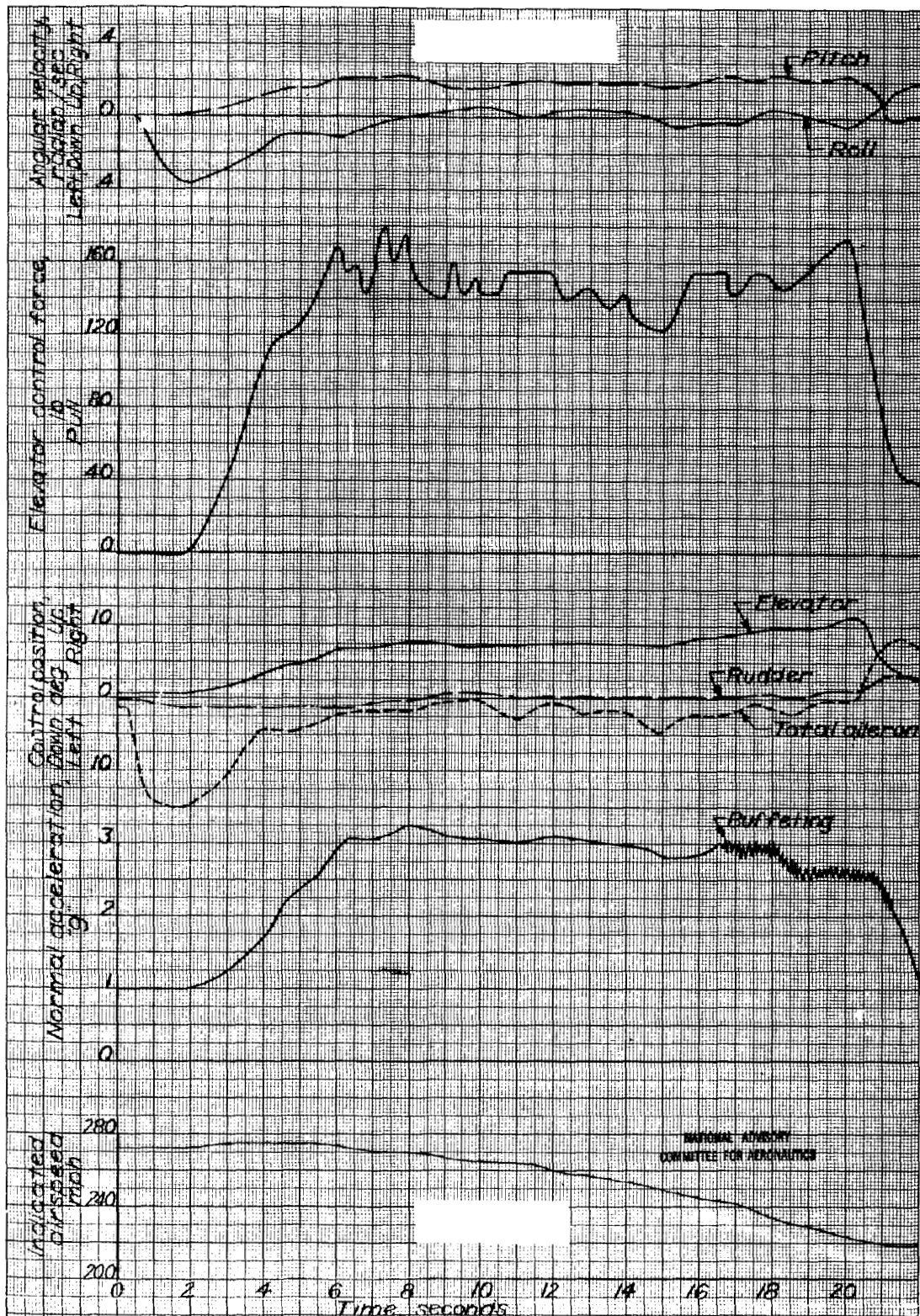
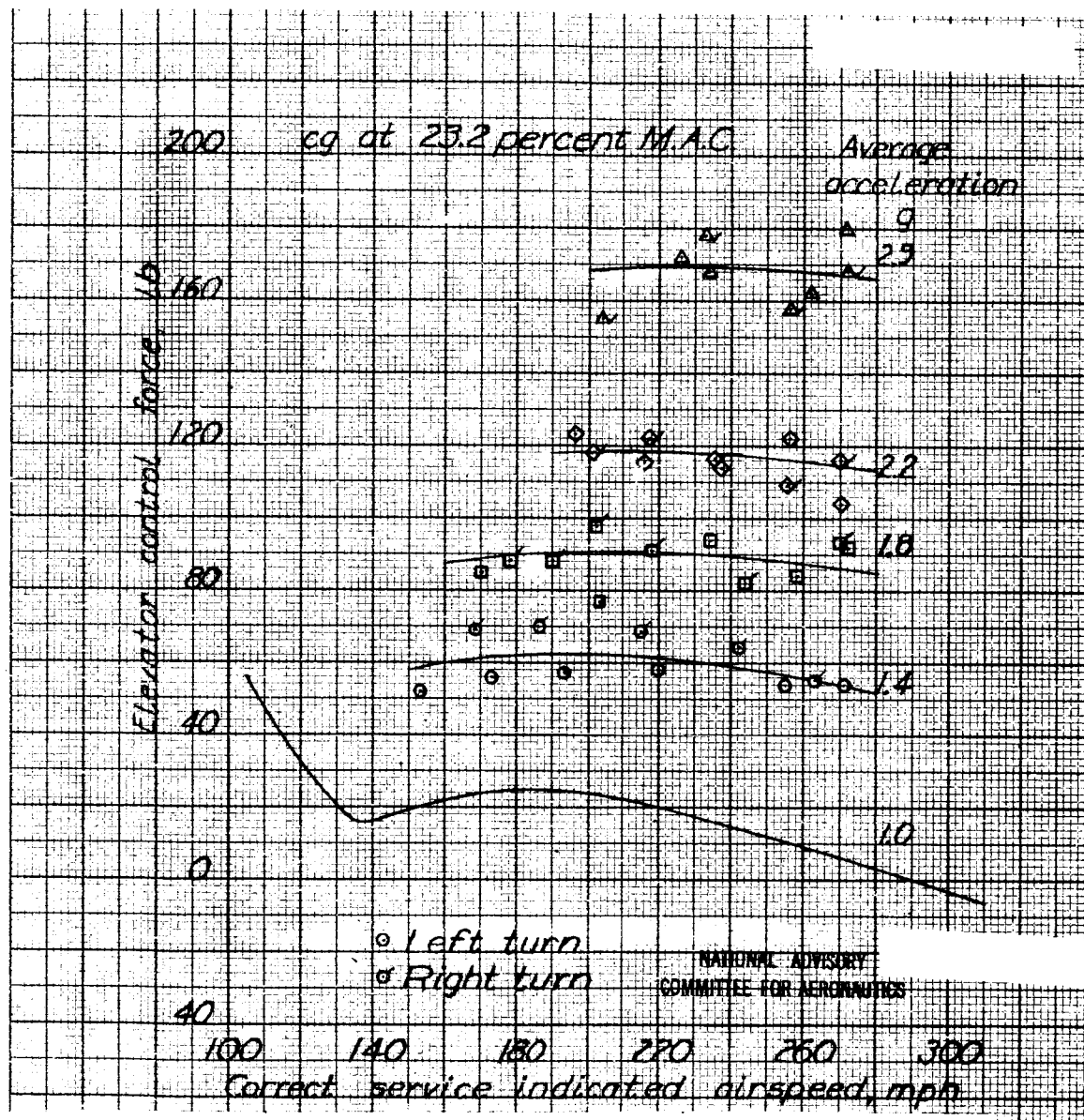


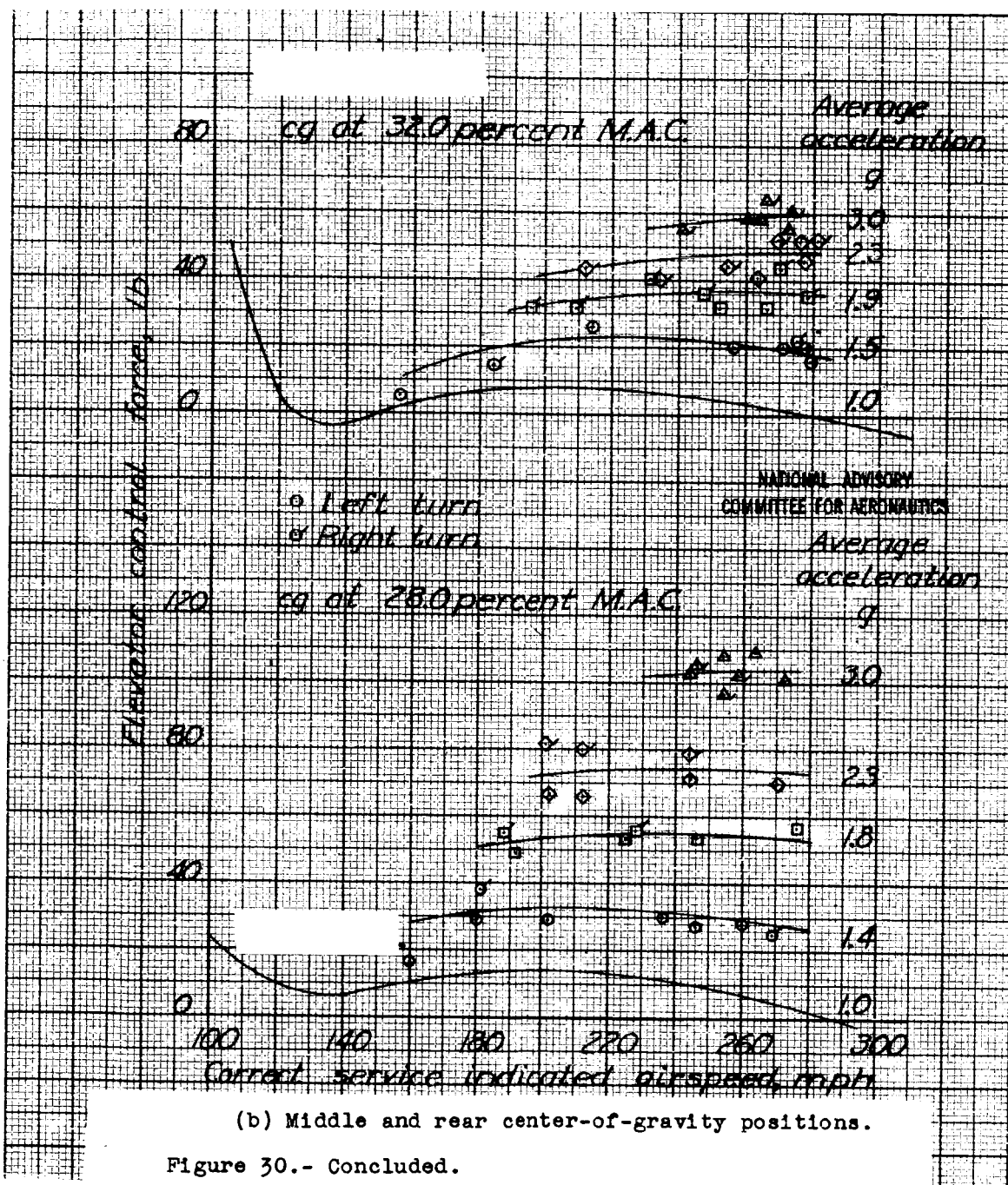
Figure 29.- Time history of a left turn in which speed was decreased from maximum level-flight speed to the stall warning, Douglas A-26 airplane with center-of-gravity position at 25 percent  $\bar{x}$ .A.C.





(a) Forward center-of-gravity position.

Figure 30.- Variation of elevator control force with speed at various accelerations in the rated-power clean condition, Douglas A-26B airplane.



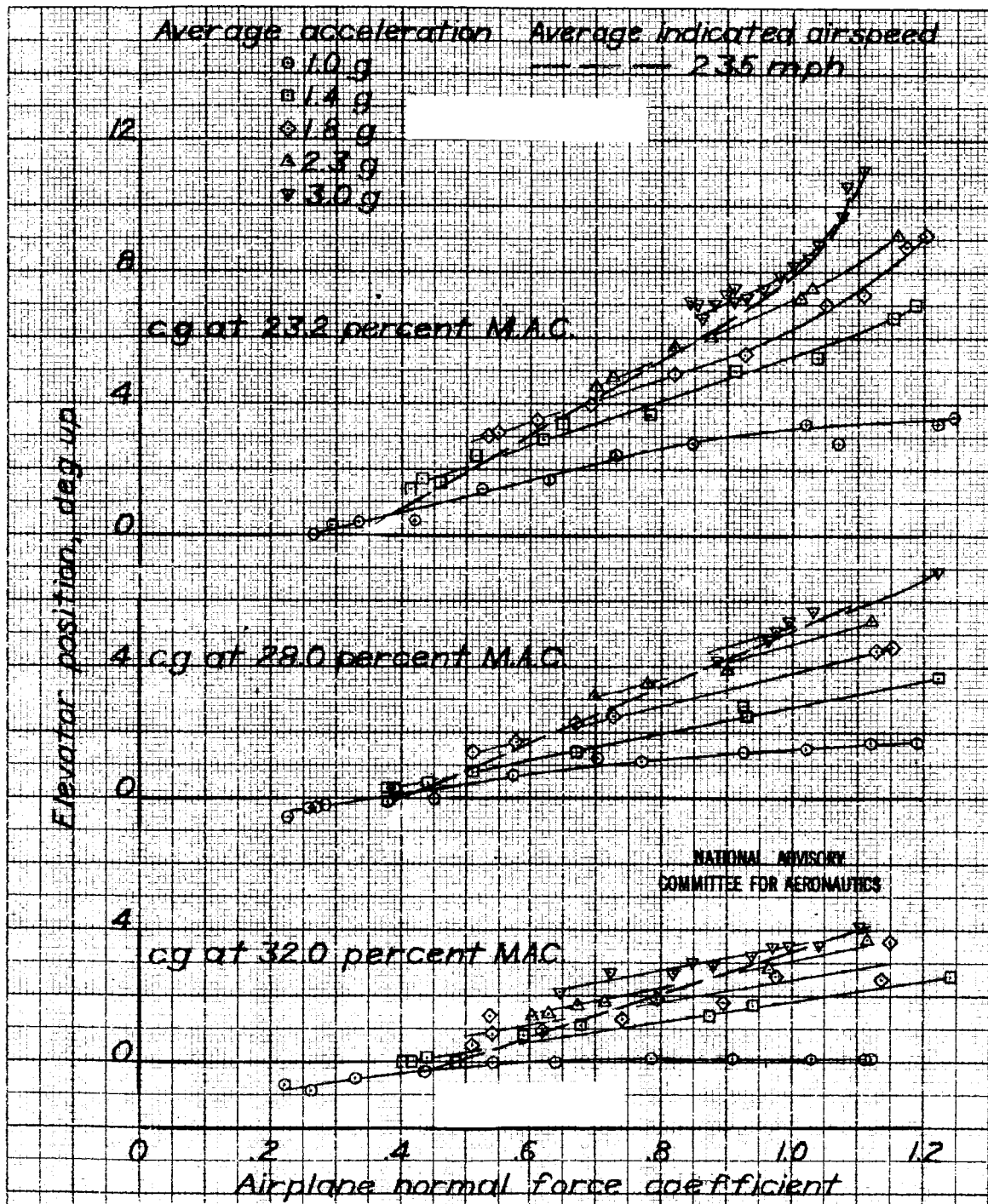


Figure 31.- Variation of elevator angle with airplane normal-force coefficient at various accelerations and at a constant indicated airspeed of 235 miles per hour in the rated-power, clean-condition, Douglas A-26B airplane.



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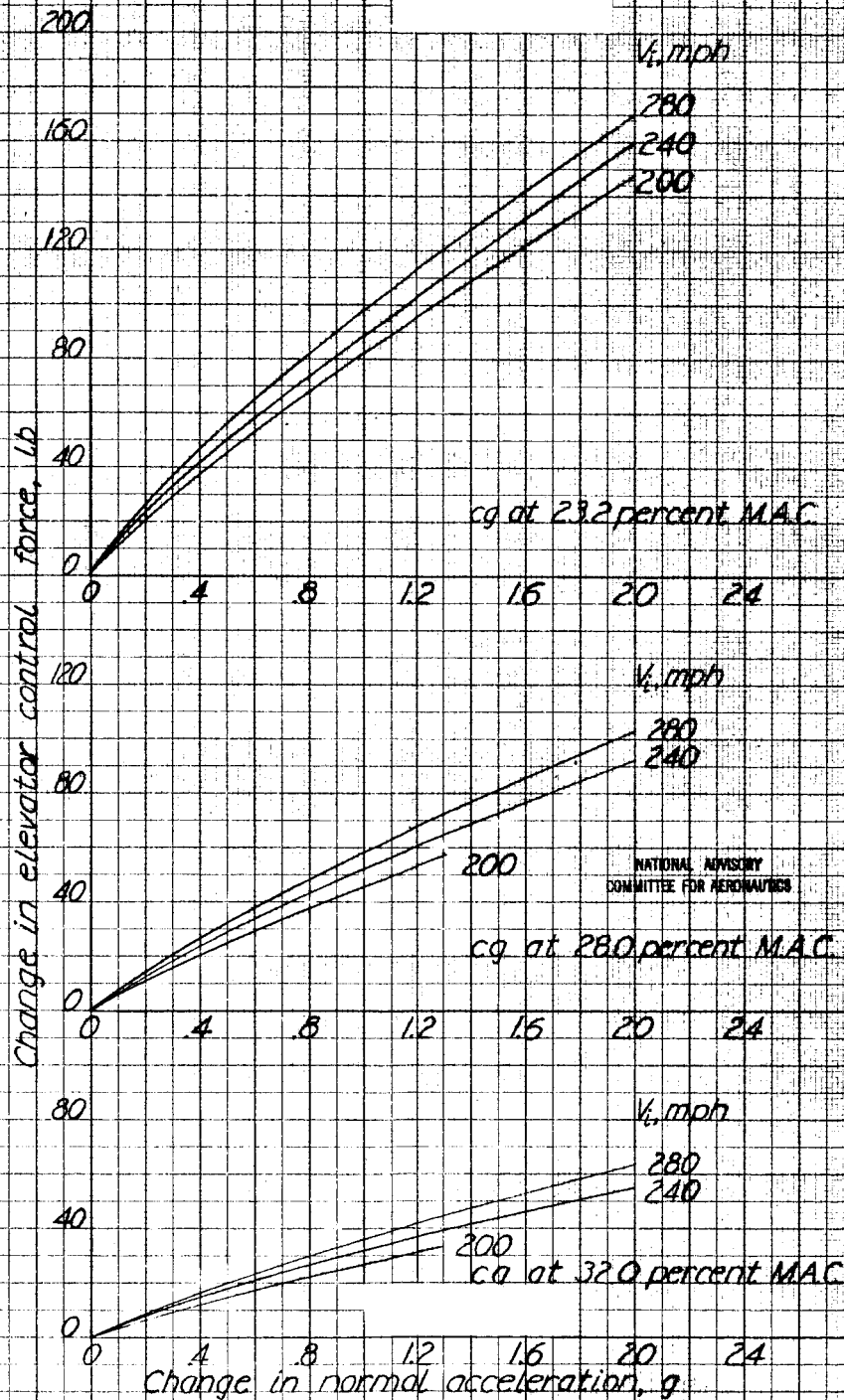


Figure 32.- Variation of elevator control force with normal acceleration at various speeds in turns made in the rated-power clean condition, Douglas A-26B airplane.

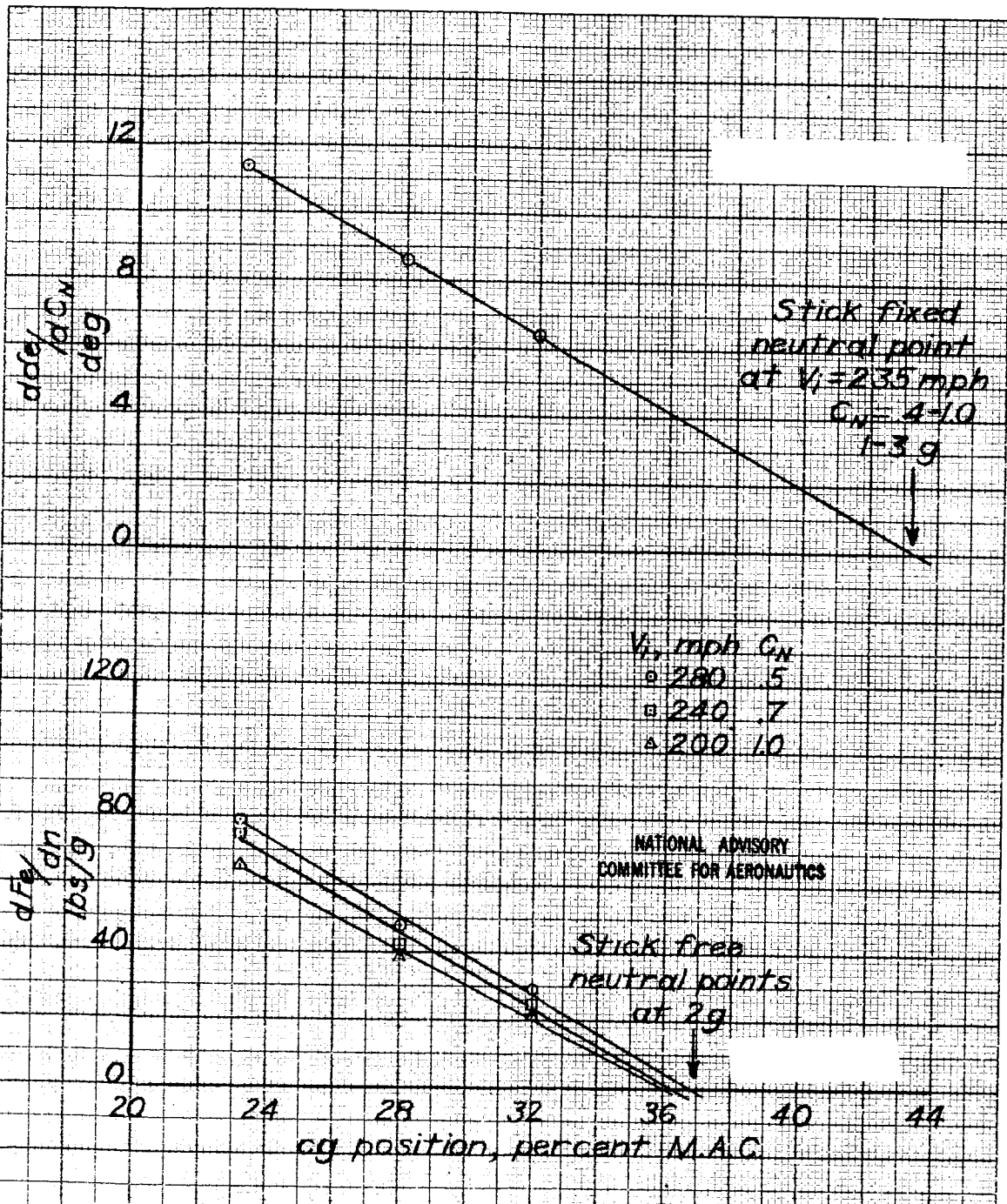


Figure 33.- Determination of neutral points for accelerated flight in the rated-power clean condition, Douglas A-26B airplane.

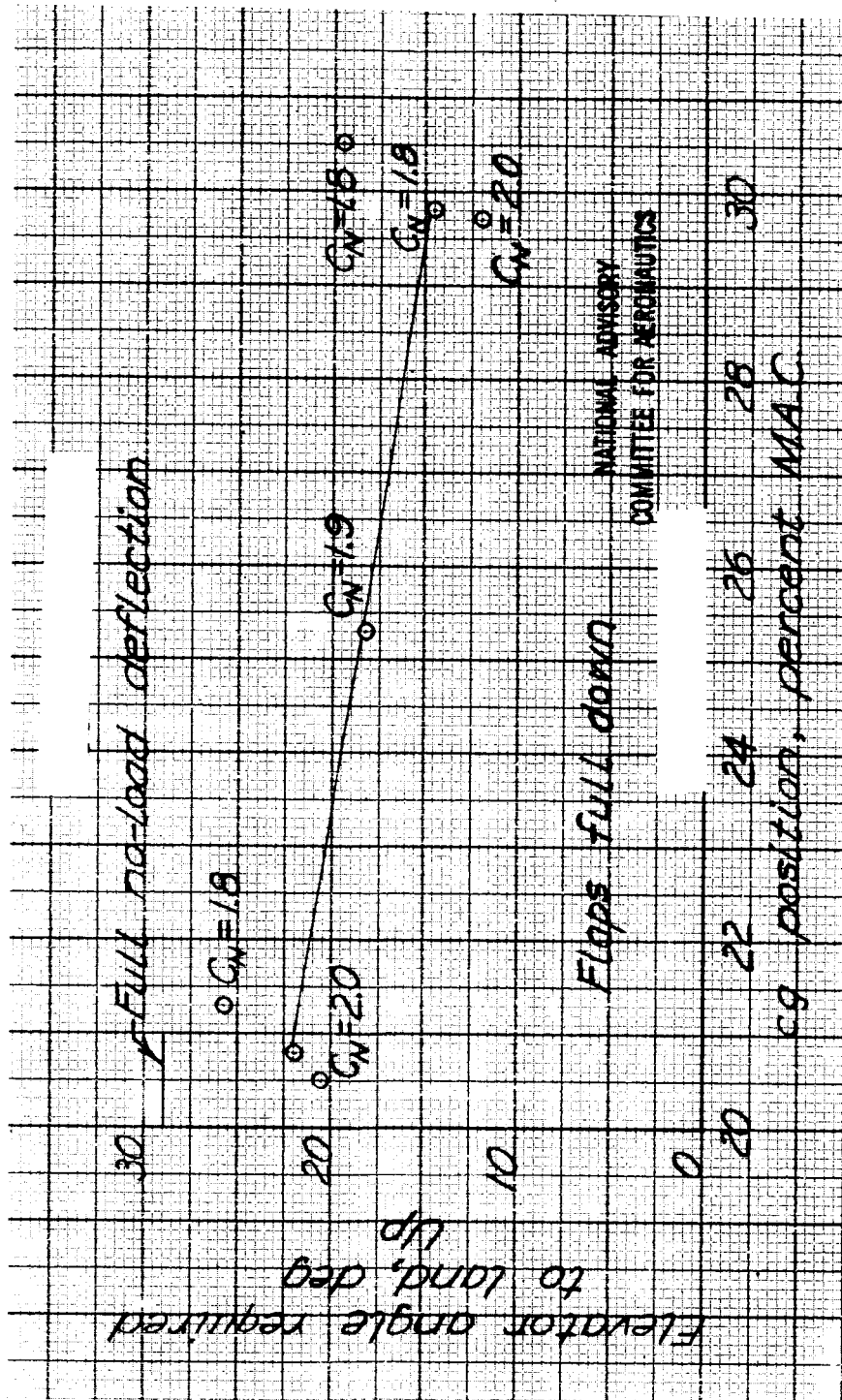


Figure 34.- Variation of elevator angle required to land with center-of-gravity position, Douglas A-26B airplane.

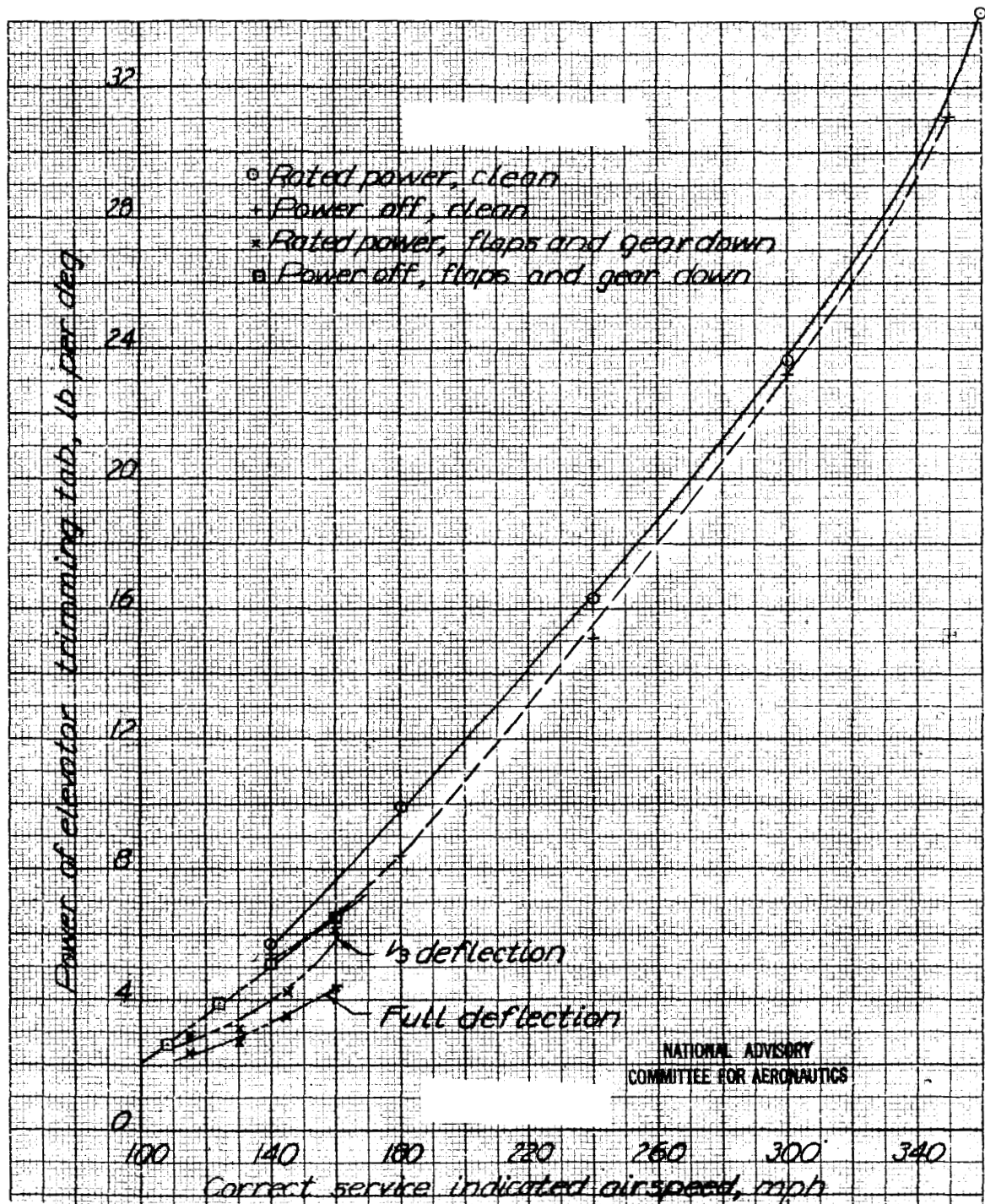


Figure 35.- Power of elevator trimming tab, Douglas A-26B airplane.

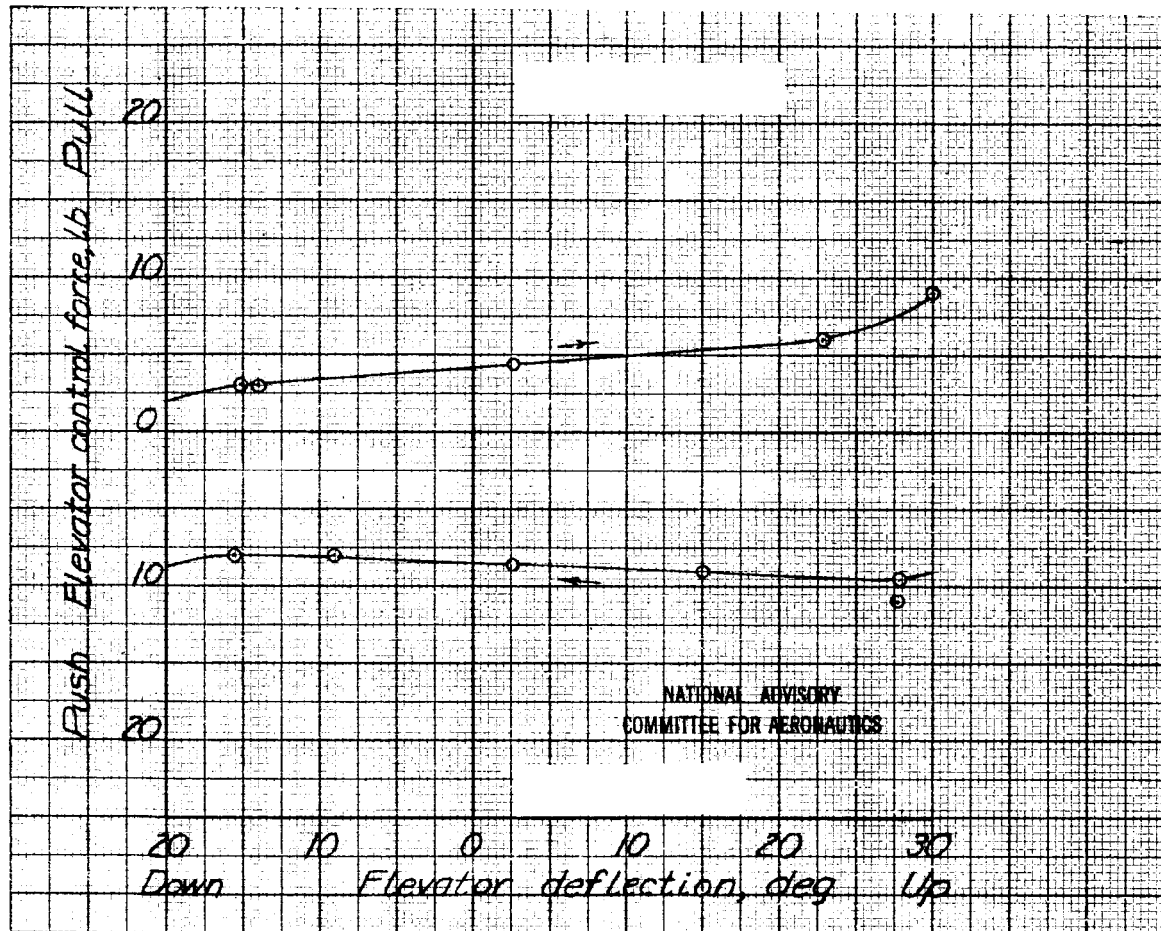


Figure 36.- Friction of elevator control system, Douglas A-26B airplane.

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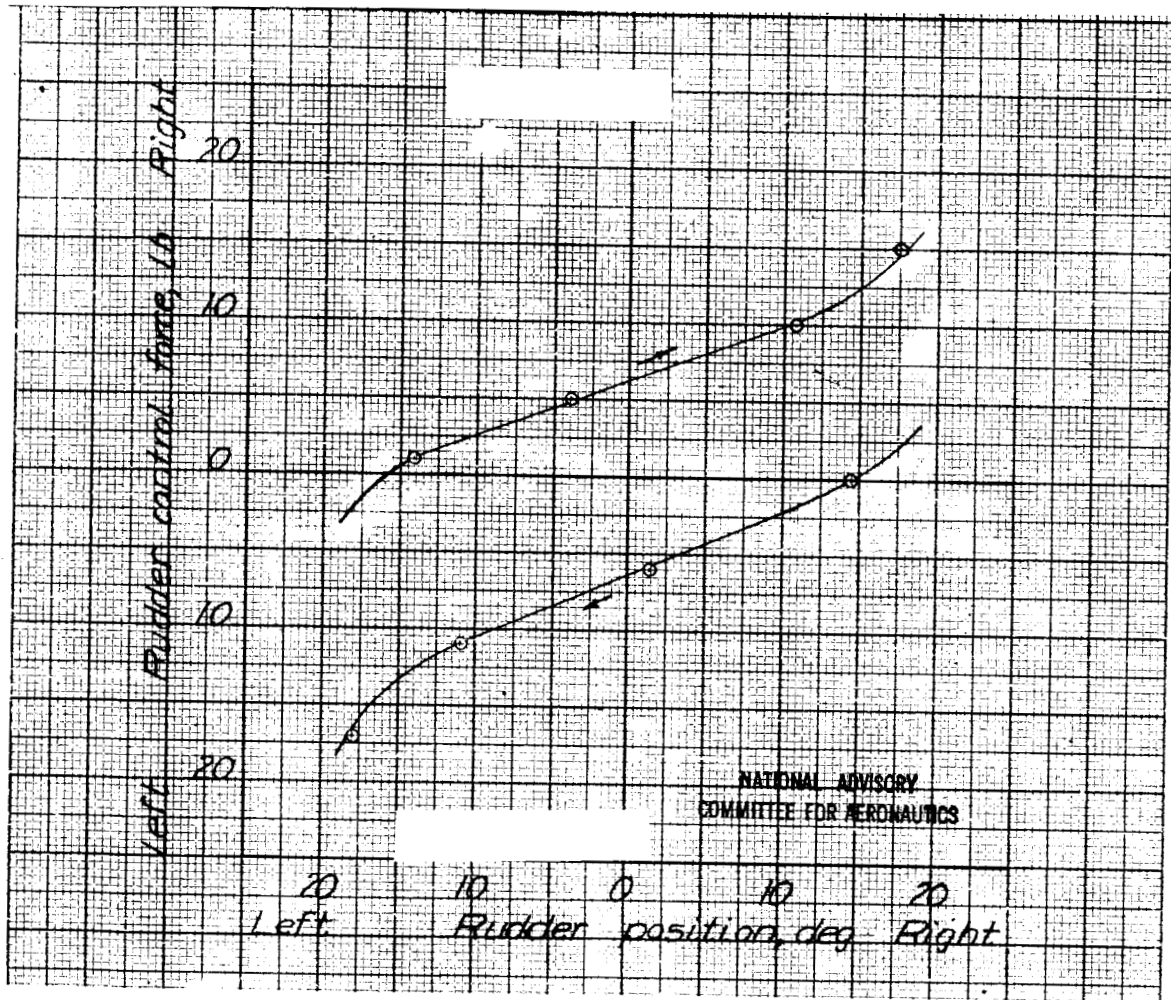


Figure 37.- Friction of rudder control system, Douglas A-26B airplane.